National Resilience Programme

Guideline for Developing Ward level Contingency Plan

National Resilience Programme (NRP): DDM Part

Ministry of Disaster Management and Relief (MoDMR)

July 2021

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Earthquake Risk Assessment for Developing Contingency Plans, Training Modules and Awareness Materials for Rangpur City Corporation and Tangail, Rangamati and Sunamganj Pourashavas

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Executive Summary

Earthquake is a sudden and calamitous event that disrupts the functioning of a community and causes widespread human, material, economic and environmental losses. The local community may not be prepared enough to recover from this using its own resources. Bangladesh is particularly vulnerable to earthquake being in a moderately seismic-prone region along with having historical evidence of major earthquakes within close vicinity. By considering this scenario it is essential to train different stakeholders like engineers, architects, planners, contractors as well as local volunteers at local level to reduce the impact of earthquake. The training of trainers was arranged to enrich the knowledge of different stakeholders and prepare them for developing "Earthquake Preparedness and Response Plans" so that they can contribute to the local capacity building. The training modules were prepared considering the society's structure, capacity, available facilities and local situation of the respective community. The training would help the current trainees and future trainers to undertake essential responsibilities to design, develop and implement the activities for ensuring earthquake resilient communities as well as structures. By this training, they are expected to plan for quick recovery and learn how to restore the damaged physical entities for continued functioning of the society after an earthquake.

The training program was comprised of four (4) modules focusing on eight (8) lessons and discussion sessions for the participants. The first lesson was designed for all stakeholders: engineers, planners, architects, contractors and volunteers, to provide them an overview of earthquake risks in context of Bangladesh. Lesson 2 and 3 described different types of vulnerabilities, their basic features and process of vulnerability assessment. Lesson 4 was designed to let the learner know about different risk reduction measures and how to operate them. Lesson 5 described the features of Bangladesh National Building Code and Lesson 6 described various aspects of construction safety and their implementation procedures. Lesson 7 and 8 focused on the overview of earthquake management, components and process of contingency planning for the planners.

The trainings of trainers was arranged over online platform due to the ongoing COVID- 19 pandemic. The whole training was three days long. At the first day Lesson 1 was delivered including all the target audiences. Initially an evaluation was taken to understand the basic understanding level of the participants regarding the risks associated to earthquake and their management. After the lecture, the same questions were answered by them, and inferences were made about the improvement in their awareness level by comparing the two results. On day two and three, parallel sessions were arranged for engineers, planners, architects and contractors following interactive question answer sessions after each session. During this and the open discussion sessions participants shared their ideas and feedbacks on the topics. It helped to provide a scenario at the field level. From the pre and post evaluation of the exam it was clear that the training helped the participants to develop a better understanding about earthquake management. Based on the results of the evaluations, 41% of the people from

Rangpur City Corporation, 31% of the trainees from Tangail Paurashava, 76% of the trainees from Sunamganj Paurashava, and finally 38% of the trainees from Rangamati Paurashava have improved their performance after the training program. Therefore it could be stated the training sessions contributed to the capacity building of the municipalities that may further help to raise awareness among the local community. These participants will help to disseminate the gained knowledge to other professionals in the study areas and enrich their expertise regarding seismic risk and its preparedness. Thus this training will work as a primary step towards the capacity building of professionals at local level.

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Overview of the Training Sessions and Training Modules

1. Introduction

Earthquake is a sudden, calamitous event that seriously disrupts the functioning of a community and causes human, material, economic and environmental losses that exceed the community's ability to cope using its own resources. It is a natural hazard that kills millions of people and destroys billions of dollars of habitat and property. The majority of damage in the event of this disaster is due to improper city planning, failure of structural design, poor infrastructural facilities, ignorance of building norms, low quality substitutes of building materials and lack of site investigations. Proper planning and mindful execution of technical support can reduce the substantial loss and damage. With a strong team of engineers, planners, architects, contractors and local volunteers, we can reduce the intensity of destruction and save thousands of lives and property. Earthquake preparedness is the creation of plans through which communities reduce vulnerability to earthquake hazards and cope with the after effect of this disaster. Earthquake preparedness does not avert or eliminate the threats; instead it focuses on creating plans to decrease the impact of disasters. Failure to create a plan could lead to damage to assets, human mortality and a lot of revenues. Engineering based mitigation options alone do not guarantee protection from natural hazards. Therefore, a holistic multi hazard perspective that integrates social, economic and environmental issues to hazard reduction are increasingly required to work across disciplines, and with involvement of many actors and stakeholders.

To reduce the impact of earthquake hazard, it is a crucial to train different stakeholders like engineers, architects, planners, contractors as well as local volunteers. The aim of the training was to assist different stakeholders for developing "Earthquake Preparedness and Response Plans". These trainings modules were prepared based on the society's structure, capacity, available facilities and local situation of the respective society. The training hoped to guide the audiences to design and implement the activities for preparedness; to develop the skill and capacity for effective response during earthquake; and plan for

quick repair, restoration of damaged physical entities for continued functioning of the society after earthquake.

The goals of the modules include improving the understanding of earthquakes and their effects (predicting & forecasting), improving techniques to reduce seismic vulnerability of facilities and systems (e.g. through the adoption of updated seismic building codes and better construction practices) and improving seismic hazards identification and risk reduction methods and their use.

2. Target Audiences

The training was offered for the following four groups of practicing professionals working for the city corporation/paurashava along with the ones appointed in the private sectors:

- Engineers
- Architects
- Planners
- Contractors
- In addition to the above, a group of volunteers were also be provided with training

3. Duration

- Three days in total where each municipality/city corporation participated. The lecture hours of each session has been detailed out in Table 1.

4. Objective

The training sessions were designed and conducted so that at the end the participants,

a) Will have enhanced understanding about earthquake hazard.
b) Will gain knowledge about different types of vulnerabilities (structural and non-structural) and their impacts during earthquake.
c) Will strengthen their capacity on earthquake risk reduction such as response and preparedness.
d) Will get the overview of the National Building Code and construction safety.
e) Will learn aspects of earthquake management and contingency planning.

5. Design of the Training Sessions

The training program was comprised of four (4) modules focusing on eight (8) lessons and discussion sessions for the participants. The first lesson was designed for all the audiences: engineers, architects, planners, contractors, and volunteers, to provide them with an overview of earthquake risks in context of Bangladesh. Lesson 2 and 3 described different types of vulnerabilities with their basic features and the process of vulnerability assessment. Lesson 4 was designed to let the learner know about different risk reduction measures and how to operate them. Lesson 5 described the features of Bangladesh National Building Code and Lesson 6 described various aspects of construction safety and their implementation procedures. Lesson 7 and 8 covered important topics of earthquake management and contingency planning for the planners. All the lessons have been attached in Appendix-I.

Table 1 shows the structure of training program with list of lessons and duration of each module.

Table 1: Content-wise time allocation for each module

Module No	Target Audience	Lessons to be covered	Duration of Lesson	Total Duration
Module 1	Engineers	Introduction to Earthquake	2 hours	13 hours
		Earthquake Vulnerability Assessment	4 hours	
		Earthquake Risk Reduction Measures	3 hours	
		Building Code Compliance	2 hours	
		Construction Safety	2 hours	
Module 2	Architects	Introduction to Earthquake	2 hours	10 hours
		Earthquake Vulnerability Assessment	3 hours	
		Earthquake Risk Reduction Measures	3 hours	

Module No	Target Audience	Lessons to be covered	Duration of Lesson	Total Duration
		Building Code Compliance	2 hours	
Module 3	Planners	Introduction to Earthquake	2 hours	12 hours
		Earthquake Vulnerability Assessment	3 hours	
		Earthquake Risk Reduction Measures	3 hours	
		Earthquake management planning and preparedness	2 hours	
		Contingency or Emergency planning	2 hours	
Module 4	Contractors	Introduction to Earthquake	2 hours	4 hours
		Construction Safety	2 hours	
	Local Volunteers	Introduction to Earthquake	2 hours	2 hours

6. Training Sessions in Four Study Areas

The trainings of the trainees was organized over online platform due to the ongoing COVID-19 pandemic. The whole training was three days long. The sessions were held from 28 June to 30 June, 2021. Figure 1 represents a glimpse of the training session and Figure 2 shows the evaluation sessions conducted before and after training.

At the first day Lesson 1 was covered which included all the target audiences. Initially an evaluation was taken to understand the basic understanding level of the participants regarding the risks associated to earthquake and their reduction measures (for the questions of the evaluation, see Appendix III). After the lecture, the same questions were answered by them once again and inferences were made about improvement in their awareness level by comparing the two results. On day two and three, parallel sessions were arranged for engineers, planners and architects and interactive question answer sessions were held after each session.

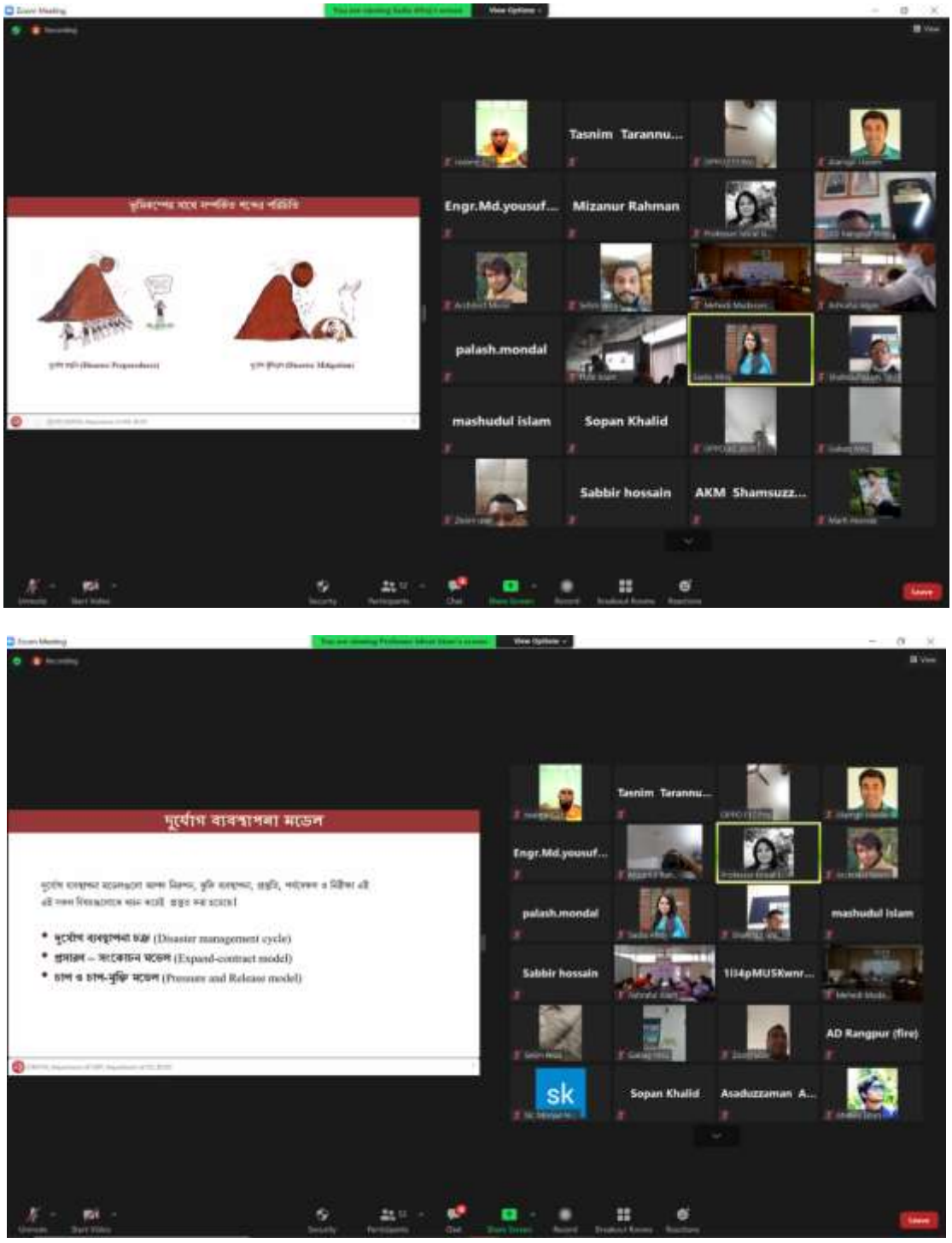

Figure 1: A glimpse of training session in an online platform

Figure 2: Participants taking part in the evaluation session

7. Participants of the Training

Participants from the mentioned target groups were present during the training. Professionals from both public and private sectors such as Rangpur City Corporation, Fire Service and Civil Defense, Tangail Paurashava, Mirzapur Paurashava, Hometech Consultant Ltd, MS Nakshi Enterprise etc. had attended the training along with sharing their views and thoughts regarding the earthquake risks and preparedness. Volunteers from urban community were also present in the introductory session. Table 2 contains the number of target audiences who participated in the training program and Table 3 shows number of participants in each session of the training program. A list of participants have been attached in Appendix-II.

Table 2: Number of target audiences participating in the training program

Participating Groups	Numbers
Engineers	35
Architects	8
Planners	5
Contractors	14
Volunteer	17

Table 3: Number of participants in each lesson

Lesson	Name of the Session	Number of participants
Lesson 1	Introduction to Earthquake	52
Lesson 2	Earthquake Vulnerability Assessment (Engineers)	29
Lesson 3	Earthquake Vulnerability Assessment (Architects & Planners)	9
Lesson 4	Earthquake Risk Reduction Measures	32
Lesson 5	Building Code Compliance	34

Lesson	Name of the Session	Number of participants
Lesson 6	Contingency or Emergency planning	32
Lesson 7	Construction Safety	11
Lesson 8	Earthquake management planning and preparedness	9

8. Discussion Session with the Participants

Open discussion sessions along with question-answers were carried out at the end of each lecture where participants shared their ideas on the topics. It helped to provide a scenario at the field level. It was emphasized by the professionals that the structures need to be made earthquake resilient from the very beginning of the construction. In order to achieve this, an understanding and sharing of knowledge among the owner, engineer, architect and planner is required. All the professionals and stakeholders associated with the land use and construction of structures need to be aware of the importance of having a structure which will be safe during an earthquake. As the safety of critical infrastructures and lifelines were discussed, the participants agreed that the coordination among different agencies and service providers can play a vital role in this regard.

The participants emphasized that the earthquake vulnerability needs to be assessed for all areas of the municipalities considering the seismic, structural and social vulnerability. Besides the assessment and the findings need to be shared with the community. In this regard, local volunteers could help to disseminate the information. So the capacity of local volunteers required be enhanced with adequate trainings and materials to generate awareness among local people regarding earthquake resiliency.

The existence of rules and legislations for making a structure earthquake resistant was applauded. However, it was mentioned that rapid urbanization is occurring in all the four study areas, thus practice and implementation of prevailing rules and regulations is a crucial challenge. The extent of work is enormous compared to the existing manpower in the city corporation and municipalities. Hence, there remains a need to expand the manpower associated with implementing various land use and design approval measures.

The planners suggested proper implementation of contingency plan needs to be ensured beside the preparation. After preparing the plan, this should be validated by the local practitioners and community. The final plan could be shared publicly to make people aware. The institutional management of the components of contingency plan could be set up collaboratively with local community and volunteers.

The participants urged to improve the competencies and capacities of local engineers, architects and planners. For this, they suggested that Bangladesh National Building Code, 2020 shall be included in the approved curriculum of the mentioned professionals.

Representatives from Rangamati Paurashava mentioned the importance of taking 3-dimensional landscapes into consideration when constructing building in such hilly areas.

It has also come up during the discussion sessions that appropriate budget shall be allocated for risk sensitive land use planning and its implementation during a project proposal. Planners shall not be limited to the planning of the project but shall also be actively involved when the project will be implemented. The necessity of gazetted masterplans of the study areas have been emphasized.

Only one group of people will not be able to make an area resilient for earthquake. There needs to be proper training along with lifelong education of the practitioners. These need to be complimented by the awareness of land owners, stakeholders and local people. A combined effort can ensure that a locality is prepared for a disaster like earthquake.

9. Evaluation of the pre and post training exam

Two exams were designed for the training participants where they were evaluated using same questions before and after the training session. These evaluations intended to know the effectiveness of the training and whether the session put any value to the disaster management knowledge base of participants. The questions were prepared focusing on basic terminologies relating to earthquake management, awareness level to respond to any earthquake, source and associated risks with earthquake, and community level preparedness. From the evaluation of the preliminary exam which was held before the training, it can be said that trainees had the basic understanding of the disaster management related terms. They were aware about the concept of hazard, disaster, vulnerability and capacity. However, the knowledge gap existed on their generic understanding of earthquake source, associated risks, earthquake preparedness and disaster management models. It is notable that most of the participants were not familiar with disaster management models before training; therefore, they could not answer the relevant questions correctly.

As the same questions were answered after the training session, the participants had a better idea about the mentioned issues and likewise they responded well on the later exam. After training they were aware of the earthquake source and its risks, they could rightly answer the relevant questions. Their knowledge on earthquake preparedness and disaster management model enriched after the training which is reflected from the post-training evaluation.

From the pre and post evaluation of the exam it was clear that the training helped the participants to develop a better understanding about earthquake management. Based on the results of the evaluations, performance improvement is shown in the figure 3. Trainees from the Sunamganj Paurashava has improved their performance significantly after the training session following by Rangpur City Corporation, Rangamati Paurashava and Tangail Paurashava.

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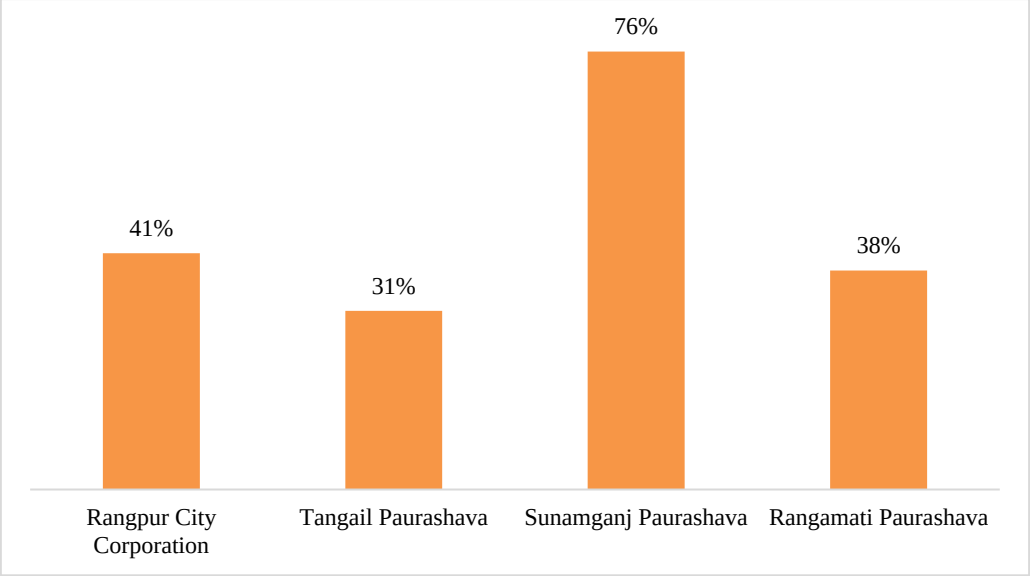


Figure 3: Performance improvement after the training

Therefore it could be stated the training sessions contributed to the capacity building of the municipalities that may further help to raise awareness among the local community.

Module 1: Training on Earthquake Preparedness for Engineers

This module is comprised of five (5) lessons: Introduction to earthquake; Earthquake vulnerability assessment; Earthquake risk reduction measures; Building code compliance; and Construction safety. A brief description of the lessons are given below:

Lesson 1: Introduction to Earthquake

Duration: 2 Hours

Facilitators:

- Prof. Dr. Ishrat Islam, Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Sadia Afroj, Lecturer, Dept. of Urban and Regional Planning, BUET

Rational:

- Bangladesh is prone to having earthquake hazard. Many of the existing structures are vulnerable to damage due to earthquake.
- The initial understanding of earthquake hazard needs to be perceived by the professionals working in construction and planning sectors, as well as by volunteers who will participate in relief, response and preparedness activities
- This module aims to provide basic understanding of earthquake, terminologies and practical ideas of the damage associated with this and, using examples from previous earthquake as a lesson. It puts emphasis on the necessity of earthquake preparedness plan and highlights the current level of preparedness of the community.

Topics covered:

- Introduction
- Terminologies associated with earthquake
- Geographical context of Bangladesh
- Historical timeline of earthquake in Bangladesh
- Effects of earthquake
- Example of some major earthquake events
- Introduction to Disaster management models with respect to Earthquake (cycle, PAR, Expand-Contract model)

Learning Outcome:

The participants are expected to

- Develop interest to act to minimize the risk

Learning Methods: Presentations and Discussion

Lesson 2: Earthquake Vulnerability Assessment

Duration: 4 Hours

Facilitators:

- Prof. Dr. Raquib Ahsan, Professor, Dept. of Civil Engineering, BUET
- Ms. Sadia Afroj, Lecturer, Dept. of Urban and Regional Planning, BUET

Rational:

- Earthquake is a natural hazard that causes casualties, damages habitat and property and results in economic loss
- Most of the damage in the event of this disaster is due to improperplanning of structures, inadequate structural design, poor infrastructural facilities, ignorance of building norms, low quality substitutes of building materials and lack of site investigations.
- This module will provide engineers a detail knowledge about identifying the seismic vulnerabilities of existing structures and how to analyze them.

Topics covered:

- Concept
- Types of vulnerabilities
- Rapid Visual Screening Process
- Detailed Engineering Assessment
- Sub-structure assessment
- Super-structure assessment
- Social vulnerability
- Critical infrastructure and lifeline vulnerability

Learning Outcome:

The participants are able to

- Identify basic vulnerabilities of buildings.

Learning Methods: Presentations and Discussion

Lesson 4: Earthquake Risk Reduction Measures

Duration: 3 Hours

Facilitators:

- Prof. Dr. Raquib Ahsan, Professor, Dept. of Civil Engineering, BUET
- Prof. Dr. Mohammad Shakil Akther, Professor, Dept. of Urban and Regional Planning, BUET

Rational:

- Proper planning and mindful execution of preparedness plan can reduce the substantial losses.
- The module will emphasize on features of land use planning for risk assessment. This will highlight advantages of resilient design and sustainable construction practices and how these can be implemented through regulatory bodies.

Topics covered:

- Introduction
- Definition and importance of Risk Sensitive Land Use Planning (RSLUP)
- Resilient design
- Sustainable Construction
- Implementation of measures (Institutional implication, legal measures for planning and building construction etc.)
- Earthquake management planning and preparedness

Learning Outcome:

The participants are expected to

- Make informed selection of different risk reduction measures.

Learning Methods: Presentations and Discussion

Lesson 5: Building CODE Compliance

Duration: 2 Hours

Facilitators:

- Prof. Dr. Raquib Ahsan, Professor, Dept. of Civil Engineering, BUET

Rational:

- The engineering design and construction of structures (e.g. buildings, lifelines etc.) to withstand earthquakes is vital for risk mitigation, particularly in areas of high seismic risk.
- The adoption of appropriate seismic building codes for buildings can help minimize their damage and reduce overall casualties.
- This module will help the professionals to get an overview of existing compliance measures, their objective and contents. It will showcase responsibilities of individuals in the implementation of such measures.

Topics covered:

- Building Act, Bangladesh National Building CODE and BC Rules
- Objective of the Building Code
- Building Code Administration
- Architectural and Fire Protection provisions
- Structural provisions
- MEP provisions
- Responsibilities of the owners and professionals

Learning Outcome:

The participants are expected to be

- Responsible in complying building code provisions

Learning Methods: Presentations and Discussion

Lesson6: Construction Safety

Duration: 2 Hours

Facilitators:

- Ms. Shamontee Aziz, Lecturer, BUET-JIDPUS

Rational:

- Safety is a major concern in the construction industry. Recent and historical data from the

construction industry worldwide, as well as Bangladesh, demonstrate that the human, social, and economic burden, inflicted because of health and safety related fatalities, is still significant.

- Knowing the risks and associated hazards is a key strategy to reduce safety risks both for the workers and public.
- This module will highlight the safety factors associated with construction that must be adopted to ensure better and secure work environment.

Topics covered:

- Introduction
- Stages of construction and construction safety plan
- Safety of workers
- Safety of public
- Safety during storage of materials
- Safety during demolition

Learning Outcome:

The participants are enable to

- Enforce construction safety in the field.

Learning Methods: Presentations and Discussion

Module 2: Training on Earthquake Preparedness for Architects

This module is comprised of four (5) lessons: Introduction to earthquake; Earthquake vulnerability assessment; Earthquake risk reduction measures; and Building code compliance. A brief description of the lessons are given below:

Lesson 1: Introduction to Earthquake

Duration: 2 Hours

Facilitators:

- Prof. Dr. Ishrat Islam, Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Sadia Afroj, Lecturer, Dept. of Urban and Regional Planning, BUET

Rational:

- Bangladesh is prone to having earthquake hazard. Many of the existing structures are vulnerable to damage due to earthquake.
- The initial understanding of earthquake hazard needs to be perceived by the professionals working in construction and planning sectors, as well as by volunteers who will participate in relief, response and preparedness activities
- This module aims to provide basic understanding of earthquake, terminologies and practical ideas of the damage associated with this and, using examples from previous earthquake as a lesson. It puts emphasis on the necessity of earthquake preparedness plan and highlights the current level of preparedness of the community.

Topics covered:

- Introduction
- Terminologies associated with earthquake
- Geographical context of Bangladesh
- Historical timeline of earthquake in Bangladesh
- Effects of earthquake
- Example of some major earthquake events
- Introduction to Disaster management models with respect to Earthquake (cycle, PAR, Expand-Contract model)

Learning Outcome:

The participants will be able to

- Develop interest to act to minimize the risk

Learning Methods: Presentations and Discussion

Lesson 3: Earthquake Vulnerability Assessment

Duration: 3 Hours

Facilitators:

- Ms. Uttama Barua, Assistant Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Shamontee Aziz, Lecturer, BUET-JIDPUS

Rational:

- The damages caused by earthquake could be influenced not only by the structural characteristics of the area but also the socio-economic condition of the respective community. A holistic approach considering both structural and socio-economic perspectives is required to identify the actual earthquake vulnerability which further can help to decide the proper earthquake risk reduction measures and management planning.
- This module is designed for architects and planners to let them be aware of the seismic vulnerabilities alongside social vulnerabilities linked with design and planning features.

Topics covered:

- Concept
- Types of vulnerabilities
- Features of structural vulnerability
- Features of non-structural vulnerability
- Social vulnerability
- Critical infrastructure and lifeline vulnerability

Learning Outcome:

The participants will able to

- Be aware about seismic vulnerabilities associated with planning and design.

Learning Methods: Presentations and Discussion

Lesson 4: Earthquake Risk Reduction Measures

Duration: 3 Hours

Facilitators:

- Prof. Dr. Raquib Ahsan, Professor, Dept. of Civil Engineering, BUET
- Prof. Dr. Mohammad Shakil Akther, Professor, Dept. of Urban and Regional Planning, BUET

Rational:

- Proper planning and mindful execution of preparedness plan can reduce the substantial losses.
- The module will emphasize on features of land use planning for risk assessment. This will highlight advantages of resilient design and sustainable construction practices and how these can be implemented through regulatory bodies.

Topics covered:

- Introduction
- Planning: Risk Sensitive Land Use Planning (RSLUP)
- Resilient design
- Sustainable Construction
- Implementation of measures (Institutional implication, legal measures for planning and building construction etc.)
- Earthquake management planning and preparedness

Learning Outcome:

The participants are able to

- Make informed selection of different risk reduction measures.

Learning Methods: Presentations and Discussion

Lesson 5: Building CODE Compliance

Duration: 2 Hours

Facilitators:

- Prof. Dr. Raquib Ahsan, Professor, Dept. of Civil Engineering, BUET

Rational:

- The engineering design and construction of structures (e.g. buildings, lifelines etc.) to withstand earthquakes is vital for risk mitigation, particularly in areas of high seismic risk.
- The adoption of appropriate seismic building codes for buildings can help minimize their damage and reduce overall casualties.
- This module will help the professionals to get an overview of existing compliance measures, their objective and contents. It will showcase responsibilities of individuals in the implementation of such measures.

Topics covered:

- Building Act, Bangladesh National Building CODE and BC Rules
- Objective of the Building Code
- Building Code Administration
- Architectural and Fire Protection provisions
- Structural provisions
- MEP provisions
- Responsibilities of the owners and professionals

Learning Outcome:

The participants are able to be

- Responsible in complying with provisions of Building Code

Learning Methods: Presentations and Discussion

Module 3: Training on Earthquake Preparedness for Planners

This module is comprised of five (5) lessons: Introduction to earthquake; Earthquake vulnerability assessment; Earthquake risk reduction measures; Earthquake management planning and preparedness; and Contingency or emergency planning. A brief description of the lessons are given below:

Lesson 1: Introduction to Earthquake

Duration: 2 Hours

Facilitators:

- Prof. Dr. Ishrat Islam, Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Sadia Afroj, Lecturer, Dept. of Urban and Regional Planning, BUET

Rational:

- Bangladesh is prone to having earthquake hazard. Many of the existing structures are vulnerable to damage due to earthquake.
- The initial understanding of earthquake hazard needs to be perceived by the professionals working in construction and planning sectors, as well as by volunteers who will participate in relief, response and preparedness activities
- This module aims to provide basic understanding of earthquake, terminologies and practical ideas of the damage associated with this and, using examples from previous earthquake as a lesson. It puts emphasis on the necessity of earthquake preparedness plan and highlights the current level of preparedness of the community.

Topics covered:

- Introduction
- Terminologies associated with earthquake
- Geographical context of Bangladesh
- Historical timeline of earthquake in Bangladesh
- Effects of earthquake
- Example of some major earthquake events
- Introduction to Disaster management models with respect to Earthquake (cycle, PAR,

Expand-Contract model)

Learning Outcome:

The participants are expected to

- Develop interest to act to minimize the risk

Learning Methods: Presentations and Discussion

Lesson 3: Earthquake Vulnerability Assessment

Duration: 3 Hours

Facilitators:

- Ms. Uttama Barua, Assistant Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Shamontee Aziz, Lecturer, BUET-JIDPUS

Rational:

- The damages caused by earthquake could be influenced not only by the structural characteristics of the area but also the socio-economic condition of the respective community. A holistic approach considering both structural and socio-economic perspectives is required to identify the actual earthquake vulnerability which further can help to decide the proper earthquake risk reduction measures and management planning.
- This module is designed for architects and planners to let them be aware of the seismic vulnerabilities alongside social vulnerabilities linked with design and planning features.

Topics covered:

- Concept
- Types of vulnerabilities
- Features of structural vulnerability
- Features of non-structural vulnerability
- Social vulnerability
- Critical infrastructure and lifeline vulnerability

Learning Outcome:

The participants are able to

- Comprehend about seismic vulnerabilities in planning and design.

Learning Methods: Presentations and Discussion

Lesson 4: Earthquake Risk Reduction Measures

Duration: 3 Hours

Facilitators:

- Prof. Dr. Ishrat Islam, Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Shamontee Aziz, Lecturer, BUET-JIDPUS

Rational:

- To mitigate the earthquake risks, it is necessary to choose the competent measures through efficient planning and designing.
- The module will provide an insight about Risk Sensitive Land Use Planning (RSLUP) considering earthquake and will also highlight the advantages of resilient design and sustainable construction practices and how these can be executed through regulatory bodies.
- This module is designed for the planners to make them aware about the effective measures to mitigate the earthquake risk through implementing proper regulations.

Topics covered:

- Introduction
- Overview of risk reduction strategies
- Definition and importance of Risk Sensitive Land Use Planning (RSLUP)
- Key considerations in RSLUP
- Basics of resilient design
- Sustainability issues in construction
- Implementation of measures for risk reduction

Learning Outcome:

The participants are expected to

- Get knowledge about the selection of different risk reduction measures.

Learning Methods: Presentations and Discussion

Lesson7: Earthquake Management Planning and Preparedness

Duration: 2 Hours

Facilitators:

- Prof. Dr. Ishrat Islam, Professor, Dept. of Urban and Regional Planning, BUET
- Prof. Dr. Mohammad Shakil Akther, Professor, Dept. of Urban and Regional Planning, BUET

Rational:

- Earthquake management process can perform through maintaining different tiers and regulatory frameworks within institutional set-up. Integration and linkages of them are necessary for improving the preparedness and effective response.
- Earthquake preparedness does not avert or eliminate the threats; instead it focuses on proper planning to decrease the damage of earthquake. .
- This module will inform the planners about earthquake management planning and preparedness at different levels as well as their institutional set-up for effective response.

Topics covered:

- Introduction
- National Level Disaster Management planning (National Disaster Management Plan; National Disaster Management Policy; SOD etc.)
- City Level Disaster Management Planning
- Community Level Disaster Management Planning
    - Institutional framework and Examples
- Household level preparedness

Learning Outcome:

The participants are expected to

- Chalk out outline of an earthquake management plan.

Learning Methods: Presentations and Discussion

Lesson8: Contingency or Emergency Planning

Duration: 2 Hour

Facilitators:

- Ms. Uttama Barua, Assistant Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Sadia Afroj, Lecturer, Dept. of Urban and Regional Planning, BUET

Rational:

- For effective earthquake response, an emergency plan or contingency plan can be prepared considering the earthquake vulnerability of the area and community.
- The components and scenario of the plan are changed according to the context incorporating the society's structure, capacity, available facilities and local situation.
- This module is prepared for the planners to train them about the framework, components and preparation of contingency planning so that quick repair and restoration of damaged physical entities and communities can be possible for the continued functioning of the society after an earthquake.

Topics covered:

- Introduction
- Conceptual framework
- Different tiers of contingency planning (National, Regional, community)
- Community level contingency planning with examples

Learning Outcome:

The participants are expected to

- Chalk out outline of a contingency plan.

Learning Methods: Presentations and Discussion

Module 4: Training on Earthquake Preparedness for Contractors

This module is comprised of two (2) lessons: Introduction to earthquake; and Construction safety. A brief description of the lessons are given below:

Lesson 1: Introduction to Earthquake

Duration: 2 Hours

Facilitators:

- Prof. Dr. Ishrat Islam, Professor, Dept. of Urban and Regional Planning, BUET
- Ms. Sadia Afroj, Lecturer, Dept. of Urban and Regional Planning, BUET

Rational:

- Bangladesh is prone to having earthquake hazard. Many of the existing structures are vulnerable to damage due to earthquake.
- The initial understanding of earthquake hazard needs to be perceived by the professionals working in construction and planning sectors, as well as by volunteers who will participate in relief, response and preparedness activities
- This module aims to provide basic understanding of earthquake, terminologies and practical ideas of the damage associated with this and, using examples from previous earthquake as a lesson. It puts emphasis on the necessity of earthquake preparedness plan and highlights the current level of preparedness of the community.

Topics covered:

- Introduction
- Terminologies associated with earthquake
- Geographical context of Bangladesh
- Historical timeline of earthquake in Bangladesh
- Effects of earthquake
- Example of some major earthquake events
- Introduction to Disaster management models with respect to Earthquake (cycle, PAR, Expand-Contract model)

Learning Outcome:

The participants are expected to

- Develop interest to act to minimize the risk

Learning Methods: Presentations and Discussion

Lesson 6: Construction Safety

Duration: 2 Hours

Facilitators:

- Ms. Shamontee Aziz, Lecturer, BUET-JIDPUS

Rational:

- Safety is a major concern in the construction industry. Recent and historical data from the construction industry worldwide, as well as Bangladesh, demonstrate that the human, social, and economic burden, inflicted because of health and safety related fatalities, is still significant.
- Knowing the risks and associated hazards is a key strategy to reduce safety risks both for the workers and public.
- This module will highlight the safety factors associated with construction that must be adopted to ensure better and secure work environment.

Topics covered:

- Introduction
- Stages of construction and construction safety plan
- Safety of workers
- Safety of public
- Safety during storage of materials
- Safety during demolition

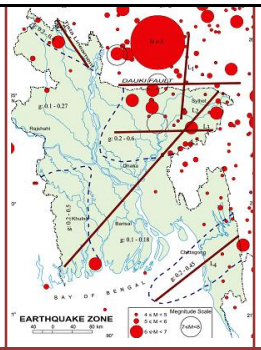
Learning Outcome:

The participants are able to

- Enforce construction safety in the field.

Learning Methods: Presentations and Discussion

APPENDIX-I



ভূমিকম্পের প্রাথমিক ধারণা

BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS),
Department of Urban and Regional Planning
Department of Civil Engineering
Bangladesh University of Engineering and Technology (BUET).
Dhaka-1000, Bangladesh.

ভূমিকম্পের প্রাথমিক ধারণা

এই আলোচনায় থাকছে-

- ভূমিকম্পের সাথে সম্পর্কিত শব্দের পরিচিতি
- ভূমিকম্প কি?
- বাংলাদেশের ভৌগলিক অবস্থানের প্রেক্ষিতে ভূমিকম্প
- বাংলাদেশে ভূমিকম্পের ঐতিহাসিক পটভূমি
- ভূমিকম্পের প্রভাব
- ভূমিকম্প কিভাবে পরিমাপ করা যায়?
- কিছু উচ্চমাত্রার ভূমিকম্পের উদাহরণ
- দুর্যোগ ব্যবস্থাপনা মডেল
- ভুমিকম্পের প্রস্তুতি ও বিপদাপন্নতা নিরূপণের ধারনা

ভূমিকম্পের সাথে সম্পর্কিত শব্দের পরিচিতি

আপদ (Hazard)

আপদ একটি অস্বাভাবিক ঘটনা, যা প্রাকৃতিক ও মানবসৃষ্ট যে কোনো কারণে ঘটতে পারে এবং যা মানুষের জীবন ও জীবিকার ব্যাপক ক্ষতিসাধন করতে পারে। আপদ দুর্যোগ নয় বরং দুর্যোগের সম্ভাব্য কারণ।

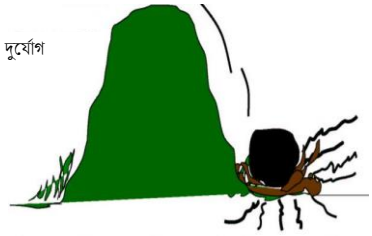
দুর্যোগ (Disaster)

প্রাকৃতিক বা মানবসৃষ্ট অথবা জলবায়ু পরিবর্তনের কারণে সৃষ্ট যে কোন ঘটনা, যার ব্যাপকতা ও ভয়াবহতা আক্রান্ত এলাকার জনগোষ্ঠী, গবাদি পশু, মৎস্যসম্পদ, স্বাভাবিক জীবনযাত্রার এরূপ ক্ষতিসাধন করে যে, যা মোকাবিলায় ঐ জনগোষ্ঠীর নিজস্ব সম্পদ, সামর্থ্য ও সক্ষমতা যথেষ্ট নয় এবং যা মোকাবিলার জন্য আক্রান্ত এলাকার বাইরে থেকে মানবিক ও অন্যান্য সাহায্যের প্রয়োজন হয়।

বিপদাপন্নতা (Vulnerability)

কোন জনগোষ্ঠীর বা তার কোনো অংশের (ব্যক্তি বা পরিবার) সামাজিক, ভৌগলিক অথবা পরিবেশগত এমন অবস্থা যার কারণে প্রকৃতি বা মানবসৃষ্ট সুনির্দিষ্ট আপদে আক্রান্ত হবার সম্ভাবনা নিয়ন্ত্রিত হয় এবং ঐ আপদ সংঘটনের ফলে জীবনযাপনের বিভিন্ন ক্ষেত্রে ক্ষয়ক্ষতির সম্ভাব্যমাত্রা নিয়ন্ত্রিত হয় ।

আপদ বিপদাপন্নতা



ভূমিকম্পের সাথে সম্পর্কিত শব্দের পরিচিতি

সক্ষমতা (Capacity)

বিপদাপন্নতা মোকাবেলার জন্য যে সকল ইতিবাচক দিক থাকে যা ফলপ্রসূভাবে সাড়া প্রদানের সক্ষমতা বৃদ্ধি করে।

দুর্যোগ ঝুঁকি (Disaster Risk)

প্রাকৃতিক বা মানবসৃষ্ট কোন আপদের কারণে জানমালের ক্ষয়ক্ষতির আশঙ্কাই হলো ঝুঁকি। ঝুঁকির সাথে জড়িত আছে তিনটি বিষয়- আপদ, বিপদাপন্নতা ও সক্ষমতা।

দুর্যোগ প্রস্তুতি (Disaster Preparedness)

সম্ভাব্য আপদের প্রভাব মোকাবিলায় জনগোষ্ঠীর মধ্যে ঝুঁকি পরিস্থিতি সম্পর্কে তাদের জ্ঞান ও ধারণার উন্নয়ন ঘটাতে এবং সম্ভাব্য দুর্যোগের ক্ষয়ক্ষতি হ্রাস, দুর্যোগ পরবর্তী সন্ধান, উদ্ধার এবং মানবিক সহয়তা কার্যক্রম পরিচালনার জন্য গৃহীত পদক্ষেপ।

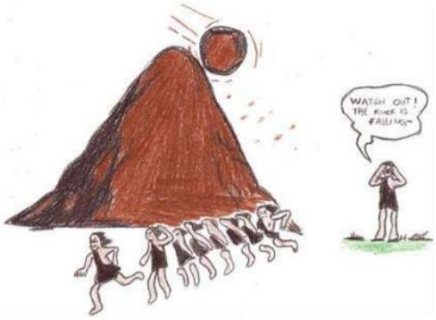
দুর্যোগ ঝুঁকিহ্রাস (Disaster Mitigation)

সম্ভাব্য আপদ সৃষ্ট ঝুঁকি দূরীকরণের বা লক্ষণীয় ভাবে হ্রাসকরণের বাস্তবায়ন প্রক্রিয়া।

জরুরি সাড়াদান (Emergency Response)

দুর্যোগের সময় বা তার ঠিক পরমুহূর্তে দুর্গত জনগোষ্ঠীর জীবনরক্ষা এবং জীবন নির্বাহ করার জন্য তাৎক্ষনিকভাবে গৃহীত ত্রাণ কর্মকাণ্ডের উদ্যোগ।

ভূমিকম্পের সাথে সম্পর্কিত শব্দের পরিচিতি



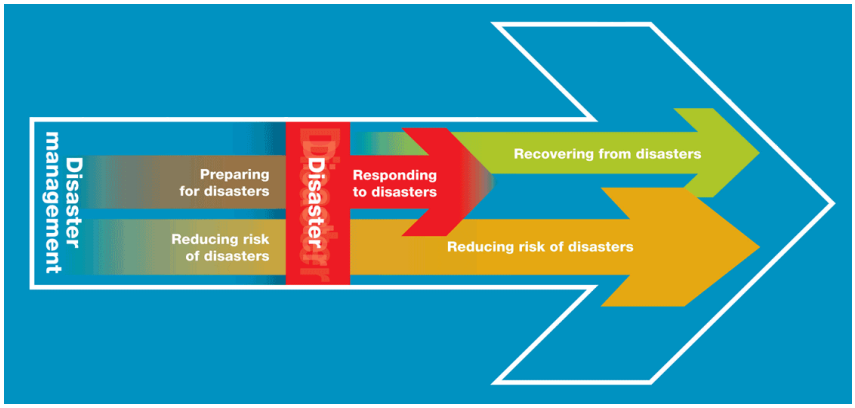
দুর্যোগ প্রস্তুতি (Disaster Preparedness)

দুর্যোগ ঝুঁকিহ্রাস (Disaster Mitigation)

ভূমিকম্পের সাথে সম্পর্কিত শব্দের পরিচিতি

দুর্যোগ ব্যবস্থাপনা (Disaster Management)

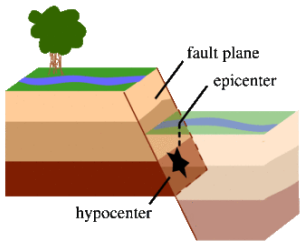
দুর্যোগের ক্ষয়ক্ষতি হ্রাসের লক্ষ্যে দুর্যোগপূর্ব, দুর্যোগকালীন ও দুর্যোগ-পরবর্তী যাবতীয় কার্যক্রমের পরিকল্পনা, সংগঠন, সমন্বয় ও নিয়ন্ত্রণসহ কর্মসূচি বাস্তবায়ন ও মূল্যায়ন পর্যন্ত সকল কর্মকান্ড সম্পাদন করাকে দুর্যোগ ব্যবস্থাপনা বলা যায়।



দুর্যোগ ব্যবস্থাপনা (IFRC, 2020)

ভূমিকম্প কি?

- ভূ-আলোড়নের ফলে ভূপৃষ্ঠের কোন অংশে আকস্মিক কম্পনের সৃষ্টি হওয়াকে **ভূমিকম্প (Earthquake)** বলে। এরূপ কম্পন প্রচন্ড, মাঝারি অথবা মৃদু আকারের হতে পারে।
- আমাদের ভূপৃষ্ঠ অনেকগুলো শিলাস্তরের সমন্বয়ে গঠিত। যখন মাটির নিচে দুটি শিলাস্তরের মধ্যে সংঘর্ষ হয়, তখন সেগুলো নিজেদের অবস্থান থেকে কিছুটা সরে যায়। ভূ-আন্দোলনের প্রভাবে ভূপৃষ্ঠের কোন লাইন বরাবর একটি শিলাস্তর থেকে পার্শ্ববর্তী শিলাস্তরের স্থানচ্যুতি ঘটলে তাকে **চ্যুতি (Fault)** বলে। এর ফলে ভূমিতে কম্পন সৃষ্টি হয়। আর এই কম্পনই ভূমিকম্প রূপে আমাদের নিকট আবির্ভূত হয়।
- ভূগর্ভস্থ যে স্থান হতে ভূমিকম্পের উৎপত্তি হয়, তাকে বলা হয় **কেন্দ্র (Hypocenter)** এবং কেন্দ্র থেকে লম্বালম্বি ভূত্বকের উপরিস্থ বিন্দুকে বলা হয় **উপকেন্দ্র (Epicenter)**।

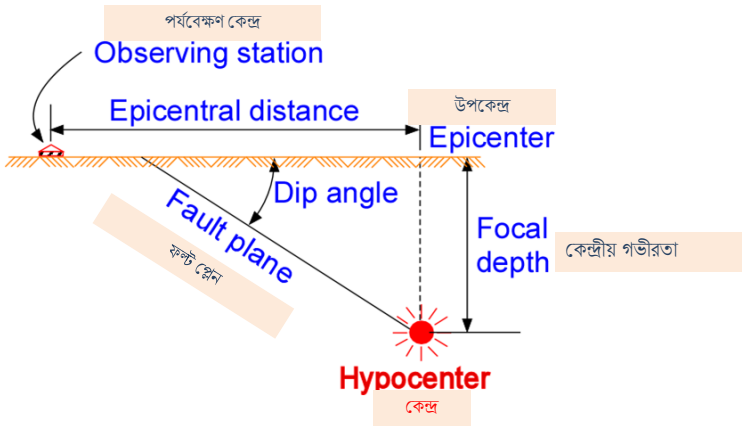


চ্যুতি তল, উপকেন্দ্র এবং হাইপোসেন্টার (USGS, 2020)

ভূমিকম্প কি?

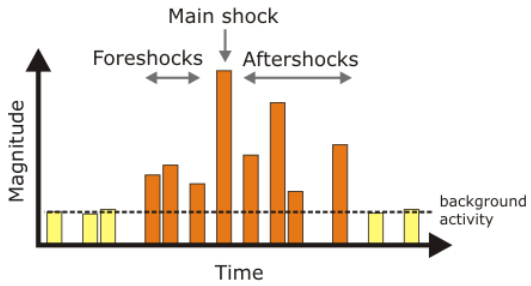
- **কেন্দ্রীয় গভীরতা (Focal Depth)**

ভূমিকম্পের উৎসের গভীরতাকে বোঝায়।



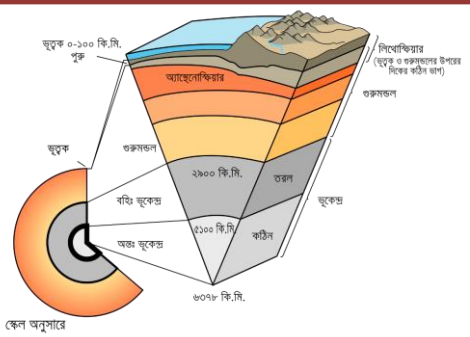
ভূমিকম্প কি?

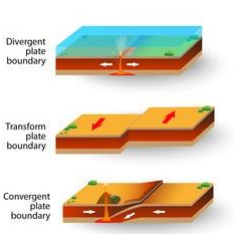
- ভূমিকম্পের পূর্বে বেশ কিছু **অনুবর্তী-অভিঘাত (foreshock)** আঘাত করতে পারে। এক্ষেত্রে, বেশ কয়েকটি ভূমিকম্প সীমিত সময়ের ও স্থানের মধ্যে ক্রমানুসারে সংঘটিত হতে পারে।
- এগুলোর মাঝে কোন একটি যদি অন্যান্যগুলোর তুলনায় অনেক বেশি শক্তিশালী হয়, তবে তাকে **মূল-অভিঘাত (mainshock)** বলা হয়। বিজ্ঞানীরা এই শক্তিশালী ভূমিকম্প আঘাত করার আগে সাধারণত মূল-অভিঘাত চিহ্নিত করতে পারেন না।
- মূল-অভিঘাতের পরে বেশ কিছু ভূকম্পন অনুভূত হতে পারে, যাদেরকে **পরবর্তী-অভিঘাত (aftershock)** নামে অভিহিত করা হয়।

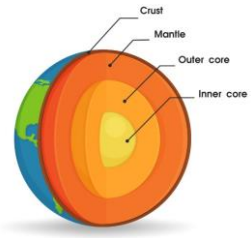


ভূমিকম্প কি?

- পৃথিবীকে মূলত চারটি প্রধান স্তরে বিভক্ত করা যায়- অন্তঃকেন্দ্র (inner core), বহিঃকেন্দ্র (outer core), ম্যান্টল (mantle) এবং ভূত্বক (crust)।
- ম্যান্টলের উপরিভাগ এবং ভূত্বক সম্মিলিতভাবে একটি শক্ত আবরণ তৈরি করে পৃথিবীকে আবৃত করেছে।
- কিন্তু এই আবরণটি কোন একক বস্তু নয়, বরং Puzzle এর মত বিভিন্ন অংশ নিয়ে গঠিত।
- এই অংশগুলো গতিশীল, কারণ এরা একে অপরের দিকে/ বিপরীতে অথবা একে অপরকে অতিক্রম করতে সক্ষম। এদেরকে বলা হয় Tectonic Plate এবং যে অংশে তারা মিলিত হয় তাকে বলা হয় প্লেট সীমানা (Plate Boundary). পৃথিবীর বেশিরভাগ ভূমিকম্প প্লেটের সংঘর্ষ অর্থাৎ ভূখন্ডীয় আন্দোলন (Tectonic Movement) এর সাথে জড়িত।

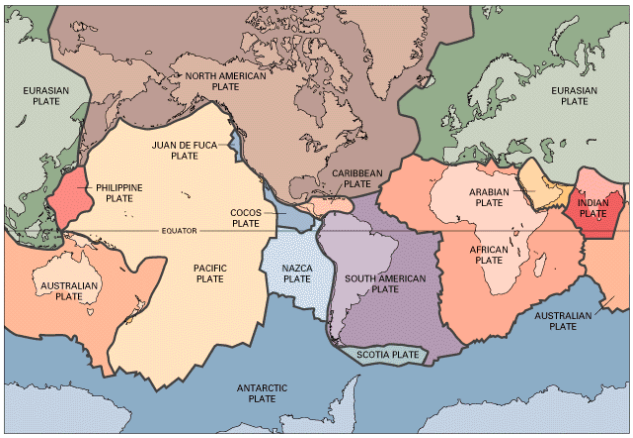






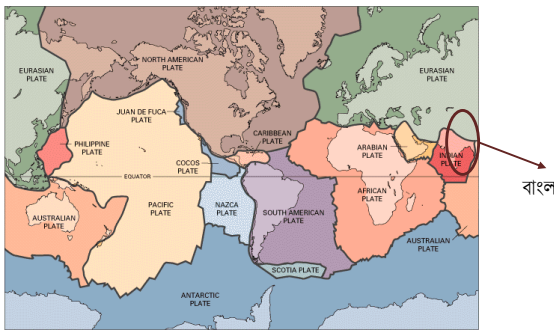
ভূমিকম্প কি?

- পৃথিবীর ভেতরের তাপ আর চাপে টেকটোনিক প্লেটগুলো গতিশীল অবস্থায় থাকে। ফলে পৃথিবী সৃষ্টির শুরু থেকেই এই প্লেটগুলো একটি অপরটির ভেতরে ঢুকে যাওয়ার চেষ্টা করছে বা ধাক্কা দিচ্ছে। যে জায়গায় এ সংঘর্ষ হয়, তাকে বলা হয় সাবসনিক জোন।
- প্লেট সীমানা অনেকগুলো চ্যুতি (fault) এর সমন্বয়ে গঠিত, এবং অধিকাংশ ভূমিকম্প এই চ্যুতি বা ফল্টের স্থানেই হয়ে থাকে। যেহেতু প্লেট সীমানা রুক্ষ এবং উঁচুনিচু, এই অংশেই প্লেটগুলো সাধারণত আটকে যায় যখন বাকি অংশগুলো বিচলন করতে থাকে।
- অবশেষে, যখন প্লেটগুলো বিচলনের মাধ্যমে অনেকদূর অগ্রসর হয়ে যায়, প্লেট সীমানা ফল্টের স্থানে বাধাপ্রাপ্ত হয় এবং ভূমিকম্প সংঘটিত হয় (USGS, 2020).



টেকটোনিক প্লেট এবং প্লেট সীমানা (USGS, 2020).

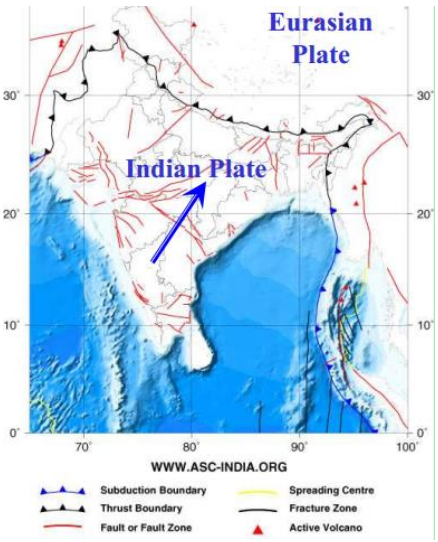
বাংলাদেশের ভৌগলিক অবস্থানের প্রেক্ষিতে ভূমিকম্প



বাংলাদেশের অবস্থান

টেকটোনিক প্লেট এবং প্লেট সীমানা (USGS, 2020)

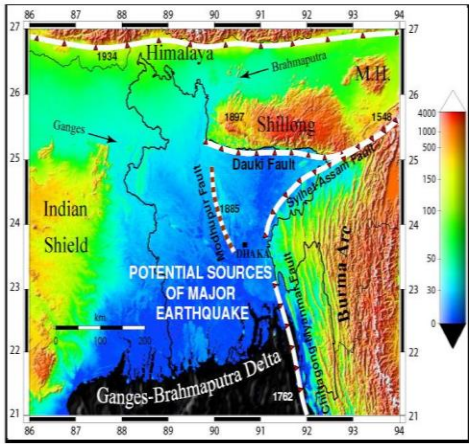
বাংলাদেশ পৃথিবীর অন্যতম ভূমিকম্প বলয়ে অবস্থিত। ভূস্তরের ভূমিকম্প প্রবণ **ইউরেশিয়া প্লেট (উত্তরে গতিশীল), ইন্ডিয়ান প্লেট (উত্তর ও পূর্বে) ও মায়ানমার সাবপ্লেটের** মাঝখানে বাংলাদেশ অবস্থিত।



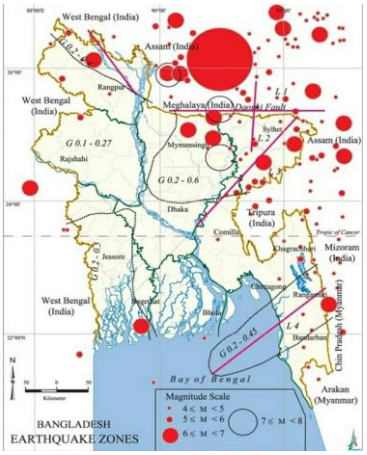
বাংলাদেশের চারিপাশে অবস্থিত টেকটোনিক প্লেট (Al-Hussaini, 2006)

বাংলাদেশের ভৌগলিক অবস্থানের প্রেক্ষিতে ভূমিকম্প

- বাংলাদেশ এবং এর আশেপাশে অবস্থিত প্রধান ফল্ট লাইনঃ



বাংলাদেশের মধ্যে ও আশেপাশে অবস্থিত ফল্ট লাইন
(Al Zaman and Monira, 2017).



বাংলাদেশের মধ্যে ও আশেপাশে সংঘটিত ভূমিকম্প ও মাত্রা

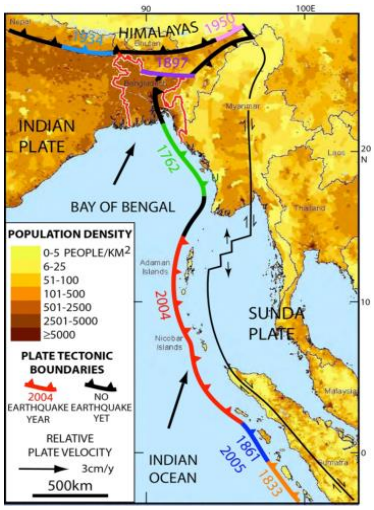
- ডাউকি ফল্ট
- মধুপুর ফল্ট
- আসাম ফল্ট
- চট্টগ্রাম- মায়ানমার ফল্ট

বাংলাদেশের ভৌগলিক অবস্থানের প্রেক্ষিতে ভূমিকম্প

- ইউরোএশিয়ান প্লেট, আরেকটি ভারত এবং ভারত মহাসাগরীয় এলাকা নিয়ে গঠিত প্লেটের জোনে রয়েছে বাংলাদেশ। এ দু'টি প্লেটের ফল্ট লাইন রয়েছে দেশের উত্তর-পূর্বাঞ্চলে সিলেটের ডাউকিতে। দু'টি প্লেটের সংঘর্ষের ফলে এই ডাউকি ফল্ট ও দক্ষিণ-পূর্বাঞ্চলের ত্রিপুরা-চট্টগ্রাম বেল্ট ৫ থেকে ৬ মিটার ভূচ্যুতি ঘটানোর মতো শক্তি অর্জন করেছে ভূগর্ভ স্তর। যেকোনো সময় বড় সংঘর্ষ হলে আঘাত হানতে পারে ভয়াবহ ভূমিকম্প, রিখটার স্কেলে যার মাত্রা হতে পারে ৭.৫।

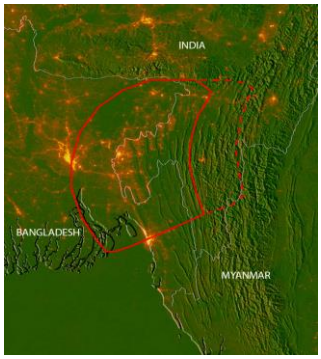
বাংলাদেশের টেকটোনিক ম্যাপ
(Akter, 2010)

বাংলাদেশের ভৌগলিক অবস্থানের প্রেক্ষিতে ভূমিকম্প



টেকটোনিক প্লেট এর মধ্যে সংঘটিত ভূমিকম্প

(Source: Earth Observatory, Columbia University, 2016)



ভূমিকম্পের ঝুঁকিপূর্ণ অঞ্চল

২০১৬ সালে Columbia University একটি গবেষণাতে দেখা গেছে, বাম পাশে লাল চিহ্নিত এলাকাটায় বড় ধরনের ভূমিকম্পের আশঙ্কা সবচেয়ে বেশি। গবেষণা মতে, ডান দিকের চিত্রে লাল চিহ্নিত (শিলং ম্যাসিফ) অঞ্চল থেকে ডেল্টা অঞ্চল (বাংলাদেশের পূর্বাঞ্চল) হয়ে ইন্দো-বার্মা ফল্ড বেল্টের দিকে ৯০ ডিগ্রি বাঁক নিয়ে ৫ থেকে ৬ মিটার ভূগর্ভ স্তরের চ্যুতি ঘটবে। **এতে ঘটবে মারাত্মক ভূমিকম্প। এই অঞ্চলের আওতায় থাকার কারণে ঢাকা, চট্টগ্রাম ও সিলেট এবং এর আশপাশের সকল স্থাপনা ধ্বংসের মুখে পড়বে।**

বাংলাদেশের ভৌগলিক অবস্থান

বাংলাদেশের ভূমিকম্প জোনিং ম্যাপ (Government of Bangladesh, 2005)

BNBC ভূমিকম্প জোনিং ম্যাপ অনুসারে, সিলেট, চট্টগ্রাম এবং টাঙ্গাইল ভূমিকম্পের উচ্চ ঝুঁকিতে আছে।

ভূমিকম্পের ঐতিহাসিক পটভূমি

অতীতের কিছু ভূমিকম্পের উদাহরণ যা বাংলাদেশকে প্রভাবিত করেছিল

তারিখ	মাত্রা	উৎপত্তিস্থল	বর্ণনা
১৮৬৯, ১০ জানুয়ারি	৭.৩৯	শিলাচর, সিলেট	কোন বড় ধরনের হতাহতের ঘটনা ঘটেনি। অনেকগুলো ভূকম্পন হয়েছিল যার কোন কোনটি পাঁচ মিনিট পর্যন্ত স্থায়ী হয়েছিল।
১৮৮৫, ১৪ জুলাই	৭.০	সাতুরিয়া, মানিকগঞ্জ	বেঙ্গল আর্থকয়েক। এই ভূমিকম্পে বিহার, সিকিম, মণিপুর (ভারত) ও মায়ানমারে বেশকিছু ভবনধস এবং প্রাণহানির রিপোর্ট পাওয়া যায়।
১৮৮৯, ১০ জানুয়ারি	৭.৫	জৈন্তিয়া পাহাড়, মেঘালয়	এটি সিলেট শহর ও তার পার্শ্ববর্তী অঞ্চলে প্রভাব ফেলে।
১৮৯৭, ১২ জুন	৮.৭	শিলং প্ল্যাটো	গ্রেট ইন্ডিয়ান আর্থকোয়েক। মৃত্যুর সংখ্যা ছিল ৫৪৫। ঢাকা, সিলেট ও ময়মনসিংহ এলাকায় প্রচুর ভবনের ক্ষয়ক্ষতি হয়। অবকাঠামোগত কারণে আর্থিক ক্ষতির সর্বমোট পরিমাণ ছিল আনুমানিক পাঁচ মিলিয়ন রুপি। এই ভূমিকম্পের ফলস্বরূপ ব্রহ্মপুত্র নদীর গতিপথ পরিবর্তন হয়ে যায় এবং নৌপরিবহন বাধাপ্রাপ্ত হয়।
১৯১৮, ১৮ জুলাই	৭.৬	শ্রীমঙ্গল, মৌলভীবাজার	কোন প্রাণহানির ঘটনা রিপোর্ট করা হয়নি। শ্রীমঙ্গলে কিছু ইটের দালান ক্ষতিগ্রস্ত হয়।
১৯২৩, ৯ সেপ্টেম্বর	৭.১	পূর্ব দুর্গাপুর, মেঘালয়	ময়মনসিংহ এলাকায় বড় ধরনের ক্ষয়ক্ষতি হয়েছিল।

রংপুরে গ্রেট ইন্ডিয়ান আর্থকোয়েক (১৮৯৭) এবং ১৯৯৭ ভূমিকম্পে রেললাইনের ক্ষতি
(Source: Ansary et al., 2003)

ভূমিকম্পের ঐতিহাসিক পটভূমি

অতীতের কিছু ভূমিকম্পের উদাহরণ যা বাংলাদেশকে প্রভাবিত করেছিল

তারিখ	মাত্রা	উৎপত্তিস্থল	বর্ণনা
১৯৩০, ৩ জুলাই	৭.১	আসাম	৬ মাত্রার ছয়টি পরবর্তী-অভিঘাত (aftershock) অনুভূত হয়েছিল। বাংলাদেশের উত্তর-পূর্ব অঞ্চল সবচেয়ে ক্ষতিগ্রস্ত হয়েছিল।
১৯৫০, ১৫ আগস্ট	৮.৭	আসাম	বাংলাদেশের কোন হতাহত না হলেও ভারতে প্রায় ১৫০০ মানুষের মৃত্যু ঘটে।
২০০৯, ১১ আগস্ট	৭.৫	উত্তর আন্দামান	এটি বে অব বেঙ্গল ভূমিকম্প হিসেবে পরিচিত। বঙ্গোপসাগরের উত্তর আন্দামান দ্বীপপুঞ্জ ও মায়ানমারের সমুদ্র সীমারেখা হতে এর উৎপত্তি। ঢাকাসহ বাংলাদেশের বেশ কয়েকটি জেলায় এর কম্পন অনুভূত হয়।
২০১১	৬.৮	সিকিম	ঢাকাসহ বাংলাদেশের উত্তরের জেলাগুলোতে প্রায় ২ মিনিটের মত কম্পন অনুভূত হয়।
২০১৫, ২৫ এপ্রিল	৭.৮	নেপাল	বাংলাদেশের বেশ কয়েকটি জেলায় এর কম্পন অনুভূত হয়।

২০১৫ নেপাল ভূমিকম্প

২০০৯ উত্তর আন্দামান দ্বীপপুঞ্জ ভূমিকম্প

ভূমিকম্পের ঐতিহাসিক পটভূমি

LAKER'S PUBLIC SCHOOL, RANGAMATI

HEALTH COMPLEX, KALABUNIA, RANGAMATI

চট্টগ্রামে ১৯৯৭ সালে ৬ মাত্রার ভূমিকম্পে সংঘটিত ভবনধস (Al-Hussaini, 2006)

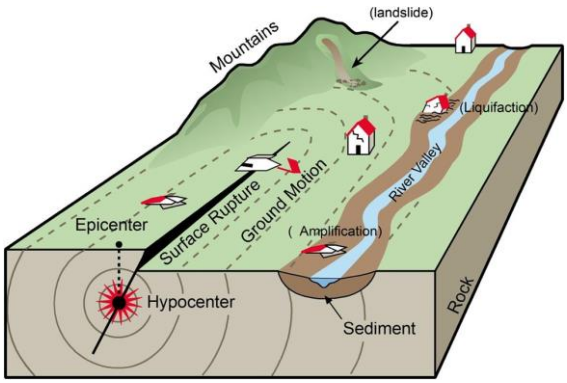
BDR CLUB, KALABUNIA, RANGAMATI

BDR CAMP, KALABUNIA, RANGAMATI

রাঙামাটি তে ২০০৫ এ সংঘটিত ভূমিকম্পের ক্ষয়ক্ষতি (মাত্রা ৫.১) (Ansari et al., 2015)

ভূমিকম্পের প্রভাব

- **প্রাথমিক প্রভাব (Primary effects)**
  - ✓ ভূমির ঝাঁকুনি (Ground shaking)
  - ✓ ভূমিতে ফাটলের সৃষ্টি (Ground rupture)
  - ✓ ভূমিধস (Landslides)
  - ✓ সুনামি (Tsunami)
  - ✓ ভূমির তরলীকরণ/ লিকুইফ্যাকশন (Liquefaction)
- **সহপার্শ্বীক দুর্যোগ (Secondary effects)**
  - ✓ অগ্নিকাণ্ড (Fire)



ভূমিকম্পের প্রভাব (Wang et.al., 2017)

ভূমিকম্পের প্রভাব

প্রাথমিক প্রভাব (Primary effects)

- **ভূমির ঝাঁকুনি (Ground shaking)**
  - ✓ ভূমিকম্পের সময়ে মাটির কম্পন বা ঝাঁকুনি হয় তা বোঝানো হয়।
  - ✓ ভূমিকম্পের মাত্রা বৃদ্ধির সাথে সাথে কম্পনও বাড়তে থাকে।
  - ✓ উৎপত্তিস্থলের সাথে দূরত্ব বৃদ্ধির সাথে কম্পন হ্রাস পায়।

ভূমির ঝাঁকুনির প্রভাব (Anderson, 2020)

- **ভূমিতে ফাটলের সৃষ্টি (Ground rupture)**
  - ✓ এটি ভূমিকম্পের অত্যন্ত গুরুত্বপূর্ণ প্রভাব। যখন ভূমিকম্পের প্রবাহ ফল্টলাইন বরাবর অগ্রসর হতে থাকে তখন তা মাটিতে ফাটলের সৃষ্টি করে। (Anderson, 2020, USGS, 2020)

ভূমিতে ফাটলের সৃষ্টি (Anderson, 2020)

ভূমিকম্পের প্রভাব

প্রাথমিক প্রভাব (Primary effects)

- **ভূমিধস (Landslides)**
  - ✓ ভূমিকম্পের কারণে ভূমি অস্থিতিশীল অথবা মাটি তরলীভূত হয়ে যাওয়ার কারণে ভূমিধস হতে পারে।
  - ✓ ভূমিধসের এলাকার ব্যাপ্তি ভূমিকম্পের মাত্রার উপর নির্ভর করে।

ভূমিধস (Anderson, 2020)

- **সুনামি (Tsunami)**
  - ✓ সাগর বা নদী বা অন্য কোন জলক্ষেত্রে ভূমিকম্পের, ভূমিধ্বসের প্রভাবে সৃষ্ট জলোচ্ছ্বাসকেই বলা হয় সুনামি।
  - ✓ ভূমির কম্পনের কারণে ফল্টের আশেপাশে ক্ষতি হতে পারে, কিন্তু সুনামি এর উৎপত্তিস্থল ছাড়াও বেশ বিস্তৃত এলাকা জুড়ে ক্ষতিসাধন করে থাকে (Anderson, 2020, USGS, 2020)

২০১১ সালে জাপানে ভূমিকম্পের সাথে সংঘটিত সুনামি

ভূমিকম্পের প্রভাব

প্রাথমিক প্রভাব (Primary effects)

- **ভূমির তরলীকরণ/ লিকুইফ্যাকশন (Liquefaction)**
  - ✓ ভূমির তরলীকরণের প্রভাবে, মাটি তার স্বাভাবিক শক্তি হারিয়ে তরল পদার্থের মতো আচরণ শুরু করে।
  - ✓ ভূমিকম্পের প্রবাহ যখন মাটির স্তরের মধ্যে দিয়ে প্রবাহিত হতে থাকে, তখন মাটির ক্ষুদ্র দানার বৈশিষ্ট্য পরিবর্তন করে দেয়
  - ✓ ইন্দোনেশিয়ার সর্বশেষ ভূমিকম্পে লিকুইফেকশনের কারণে প্রায় ১ হাজার ৭শ বাড়িঘর কার্যত মাটিতে ডেবে গিয়েছিল।

ভূমির তরলীকরণ ১৯৬৪ সালের নিগাটা ভূমিকম্পে (Anderson, 2020)

সহপার্শ্বীক দুর্যোগ (Secondary effects)

- **অগ্নিকাণ্ড (Fire)**

✓ ভবনের বিদ্যুতের লাইন, গ্যাসের লাইন, পানির লাইন ইত্যাদি ধ্বংস হতে পারে যা অগ্নিকাণ্ডের সুত্রপাত ঘটাতে পারে। (Anderson, 2020, USGS, 2020)

অগ্নিকাণ্ড(Anderson, 2020)

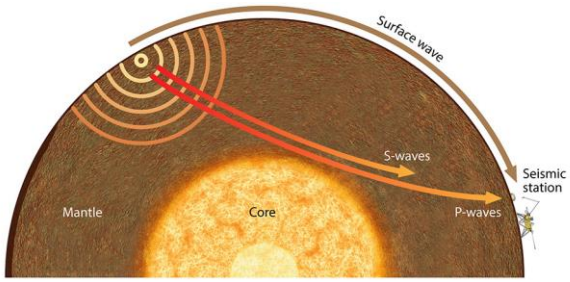
ভূকম্পন তরঙ্গ/ ওয়েভ

- ভূকম্পন তরঙ্গ (Seismic wave) হচ্ছে ভূমিকম্প, বা বিস্ফোরণ/ কোন শক্তিশালী উৎস থেকে সৃষ্ট শক্তির তরঙ্গীয় রূপ।
- এগুলো ভূপৃষ্ঠের কাছাকাছি অথবা ভূ-অভ্যন্তরে বিচরণ করে।

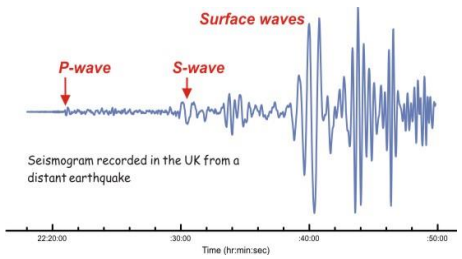
- **প্রাথমিক তরঙ্গ (P-Wave):**
  - ভূ-অভ্যন্তরীণ তরঙ্গ
  - গতিবেগ বেশি, ফলে এটি দ্রুত ভূমিকম্প পরিমাপক কেন্দ্রে গিয়ে পৌঁছায়।
  - এগুলিই প্রথমে সিসমোগ্রাফে আবির্ভূত হয়, যার কারণে এদেরকে প্রাথমিক তরঙ্গ বলা হয়।

- **গৌণ তরঙ্গ (S-Wave):**
  - ভূ-অভ্যন্তরীণ তরঙ্গ
  - এই তরঙ্গগুলির কারণে কঠিন সঞ্চারণ মাধ্যমটি ভূমিকম্পের সঞ্চারণের দিকের সাথে লম্বভাবে উপরে-নিচে ওঠানামা করে

- **ভূ-পৃষ্ঠতলীয় তরঙ্গ (Surface Wave):**
  - ভূপৃষ্ঠ বরাবর ভ্রমণকারী তরঙ্গ

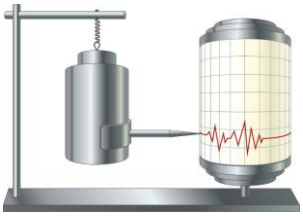


ভূকম্পন তরঙ্গ (Seismic wave)

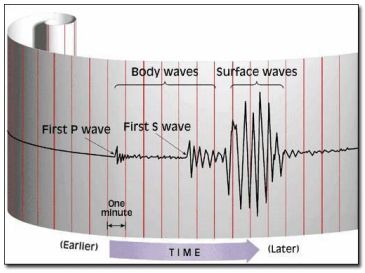


ভূমিকম্প কিভাবে পরিমাপ করা যায়?

- ভূমিকম্পকে দুইভাবে পরিমাপ করা যায়- **মাত্রা [Magnitude (M)] এবং তীব্রতা/ব্যাপকতা [Intensity (I)]**
- মূলত ভূমিকম্পের ফলে সৃষ্ট তরঙ্গ রেকর্ড করা হয় সিসমোমিটার দিয়ে (Seismometer)। ভূমিকম্পের ফলে সৃষ্ট কম্পনের মাত্রা দিয়ে যে রেখাচিত্র তৈরি করা হয়, তাকে বলা হয় সিসমোগ্রাফ (Seismograph)। সিসমোমিটারে রেকর্ড হওয়া ভূকম্পনের বিস্তার, ভূমিকম্পের উৎপত্তিস্থল থেকে সিসমোমিটারের দূরত্ব, ভূমিকম্পের স্থায়িত্ব ইত্যাদি বিবেচনা করে ভূমিকম্পের মাত্রা মাপা হয়।
- মাত্রা পরিমাপের স্কেল- রিখটার স্কেল এবং মোমেন্ট ম্যাগনিচিউড স্কেল। ১৯৩৫ সালে মার্কিন ভূবিজ্ঞানী C.F.K. Richter রিখটার স্কেল তৈরি করেন।
- রিখটার স্কেলে প্রতিটি এককে নির্দিষ্ট মাত্রার ভূমিকম্প এবং এর ক্ষয়ক্ষতির ব্যাপকতা বর্ণনা করা আছে। এই স্কেলে সর্বোচ্চ ভূমিকম্পের মাত্রা হলো ৮.২ থেকে ১০। রিখটার স্কেলের ১০ হলো প্রাণঘাতী বা সর্বোচ্চ তীব্রতাসম্পন্ন ভূমিকম্প । (দুর্যোগকোষ, ২০০৯, USGS, 2020).

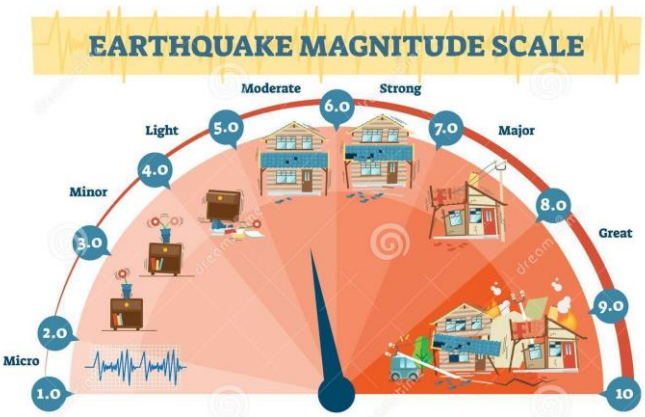


সিসমোমিটার (Seismometer)



সিসমোগ্রাফ (Seismograph)

ভূমিকম্প কিভাবে পরিমাপ করা যায়?



রিখটার স্কেল	ভূমিকম্পের প্রভাব
০-২	কম্পন অনুভূত হবেনা
২-৩	সামান্য কম্পন অনুভূত হবে
৩-৪	সিলিং ফ্যান/ লাইট দুলতে থাকবে
৪-৫	দেয়ালে ফাটল ধরবে
৫-৬	আসবাবপত্র নড়তে থাকবে
৬-৭	কিছু ভবন ধসে পরতে পারে
৭-৮	প্রচুর ভবন ধসে পরতে পারে
৮+	ভবন, রাস্তা, ব্রিজ ইত্যাদি সম্পূর্ণ ধ্বংস হবে

Source: SMS Tsunami Warning, Derived fromhttps://www.sms-tsunami-warning.com/pages/seismology-measurement#.UnksOuKFeSo

ভূমিকম্প কিভাবে পরিমাপ করা যায়?

- ভূমিকম্পের তীব্রতা/ব্যাপকতা (Intensity) সাধারণত সংশোধিত মার্কেলি স্কেলে মাপা হয় ও রোমান সংখ্যায় প্রকাশ করা হয়।
- Intensity (তীব্রতা) ভূমিকম্পের ক্ষয়ক্ষতির পরিমাণ নির্দেশ করে এবং ভূমিকম্প সংঘটিত হওয়ার পর তা মাপা হয়।
- প্রচণ্ডতার দিকে লক্ষ্য রেখে ভূমিকম্পের তীব্রতাকে ভয়াবহ (Violent), প্রচণ্ড (Severe), মাঝারি (Moderate), মৃদু (Mild) ইত্যাদিতে আখ্যায়িত করা হয়।
- স্থানভেদে ভূমিকম্পের তীব্রতা ভিন্ন হতে পারে, যা মূলত নির্ভর করে ফল্টলাইন থেকে দূরত্বের উপর।
- একই ভূমিকম্পের মাত্রা সমান কিন্তু বিভিন্ন স্থানে বিভিন্ন তীব্রতা হতে পারে।
- তীব্রতা পরিমাপ করতে দুই ধরনের স্কেল ব্যবহৃত হয়-
  - ✓ Modified Mercalli scale (MM)
  - ✓ Medvedev-Sponheur-Karnik scale (MSK)

Modified Mercalli intensity scale (source: UN 1991)

Mercalli Intensity	Magnitude	Witness Observations
I	1 to 2	Felt by very few people; barely noticeable.
II	2 to 3	Felt by a few people, especially on upper floors.
III	3 to 4	Noticeable indoors, especially on upper floors, but may not be recognized as an earthquake.
IV	4	Felt by many indoors and few outdoors. May feel like heavy truck passing by.
V	4 to 5	Felt by almost everyone, some people awakened. Small objects moved. Trees and poles may shake.
VI	5 to 6	Felt by everyone. Difficult to stand. Some heavy furniture moves, some plaster falls. Chimneys may be slightly damaged.
VII	6	Slight to moderate damage in well built, ordinary structures. Considerable damage to poorly built structures.
VIII	6 to 7	Little damage in specially built structures. Considerable damage to ordinary buildings, severe damage to poorly built structures.
IX	7	Considerable damage to specially built structures, buildings shifted off foundations. Ground cracked noticeably. Landslides.
X	7 to 8	Most masonry and frame structures and their foundations destroyed. Ground badly cracked. Landslides.
XI	8	Total damage. Few, if any, structures standing. Bridges destroyed. Wide cracks in ground. Waves seen on ground.

কিছু উচ্চমাত্রার ভূমিকম্পের উদাহরণ

তোহোকু ভূমিকম্প ও সুনামি, জাপান (২০১১)

- ২০১১ তোহোকু ভূমিকম্প ও সুনামি হলো ২০১১ সালের জাপানের উত্তর-পূর্বাঞ্চলে রিখটার স্কেলে ৯.০ মাত্রার একটি ভূমিকম্প।
- এর ফলে ওই অঞ্চলে ১০ মিটার (৩৩ ফিট) উচ্চতার সুনামিও আঘাত হানে।
- সরকারিভাবে ১৩,৩৩৩ জনের প্রাণহানির খবর প্রকাশ করা হয়, আহতের সংখ্যা বলা হয় ৪,৮৭৮,২৮২। নিখোঁজ ১৫,১৫০ জন।
- অন্তত ৩টি পারমাণবিক বিদ্যুৎকেন্দ্রে হাইড্রোজেনের পরিমাণ বেড়ে প্ল্যান্টটি গরম হয়ে যাওয়ায় এ বিস্ফোরণ ঘটে।

তোহোকু ভূমিকম্প ও সুনামি
(Wikepedia, 2020)

কিছু উচ্চমাত্রার ভূমিকম্পের উদাহরণ

নেপাল ভূমিকম্প (২০১৫)

- ২০১৫ সালের ২৫ এপ্রিল, নেপাল ভূমিকম্প (মাত্রা ৭.৮, সর্বোচ্চ তীব্রতা IX) কাঠমন্ডু শহরের নিকটে আঘাত হানে।
- প্রায় ৯,০০০ জন নিহত হয় এবং হাজার মানুষ আঘাতপ্রাপ্ত হয়।
- কাঠমন্ডু শহরে প্রায় ৬০০,০০০ এরও বেশি ভবন ক্ষতিগ্রস্ত অথবা সম্পূর্ণ ধ্বংস হয়ে যায়।
- এই ভূমিকম্পে ফলে মাউন্ট এভারেস্টে মৃত্যুসংখ্যা ২০১৪ সালের তুষারধ্বসে মৃত্যুসংখ্যাকে ছাড়িয়ে যায়।
- কাঠমন্ডু শহরে অবস্থিত শতাব্দীপ্রাচীন ইউনেস্কো বিশ্ব ঐতিহ্যবাহী স্থানসমূহ ভূমিকম্পের ফলে ভীষণভাবে ক্ষতিগ্রস্ত হয়।
- নেপাল জুড়ে ক্রমাগত ছোট্ট কম্পন ঘটে এবং স্থানীয় ০৭:০৯:০৮ (ইউটিসি) সময়ে আরেকটি ৬.৭ মাত্রার ভূমিকম্প ২৬শে এপ্রিল আঘাত হানে।(Encyclopædia Britannica, 2020).

নেপাল ভূমিকম্প
(Encyclopædia Britannica, 2020)

দুর্যোগ ব্যবস্থাপনা মডেল

দুর্যোগ ব্যবস্থাপনা মডেলগুলো আপদ নিরুপন, ঝুকি ব্যবস্থাপনা, প্রস্তুতি, পর্যবেক্ষণ ও নিরীক্ষা এই এই সকল বিষয়গুলোকে ধারন করেই প্রস্তুত করা হয়েছে।

- **দুর্যোগ ব্যবস্থাপনা চক্র** (Disaster management cycle)
- **প্রসারণ – সংকোচন মডেল** (Expand-contract model)
- **চাপ ও চাপ-মুক্তি মডেল** (Pressure and Release model)

দুর্যোগ ব্যবস্থাপনা মডেল

দুর্যোগ চক্র

- দুর্যোগ ব্যবস্থাপনায় পরস্পর সম্পর্কিত পর্যায় গুলোকে দুর্যোগ চক্র বলে।
- এই মডেল অনুসারে দুর্যোগ ব্যবস্থাপনা কয়েকটি অধ্যায়ে ক্রমানুসারে হয়।
- এই ক্ষেত্রে দুর্যোগের আগে ও পরের কার্যাবলীর উপর বিশেষ গুরুত্ব দেয়া হয়।

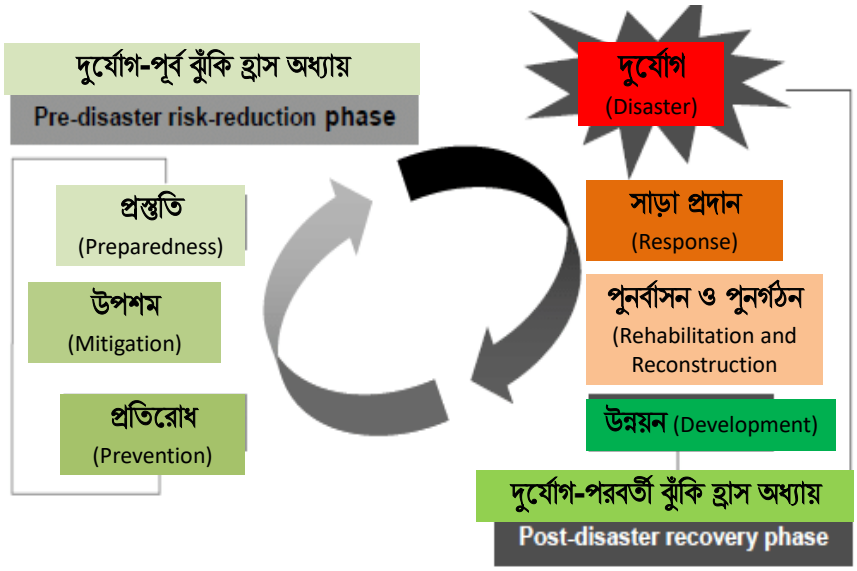


Figure 20: Traditional model – sequences of action (ADPC, n.d).

দুর্যোগ ব্যবস্থাপনা মডেল

প্রসারণ – সংকোচন মডেল

(Expand-contract model)

- দুর্যোগ ব্যবস্থাপনাকে চলমান প্রক্রিয়া হিসেবে দেখা হয়।
- এই ক্ষেত্রে দুর্যোগ বিষয়ক কার্যক্রম ক্রমানুসারে চলার পরিবর্তে সমান্তরাল ভাবে চলে।
- প্রয়োজন ও পরিস্থিতি অনুযায়ী কাজগুলোর পরিধি প্রসারিত ও সংকুচিত হয়।
- যেমন, দুর্যোগের পরপরই ত্রান ও সাড়া প্রদান কার্যক্রম সর্বাধিক গুরুত্ব পায় ও বিস্তৃত আকারে চলে।
- পরবর্তীতে পুনর্বাসন ও পুনর্গঠন কার্যক্রমের পরিধি বাড়ে।
- বিভিন্ন ধাপের গুরুত্ব নির্ভর করে দুর্যোগ ও আপদের সাথে ঝুঁকির মাঝে থাকা কমিউনিটির বিপদাপন্নতার সম্পর্ক অনুসারে।

(ADPC, n.d).

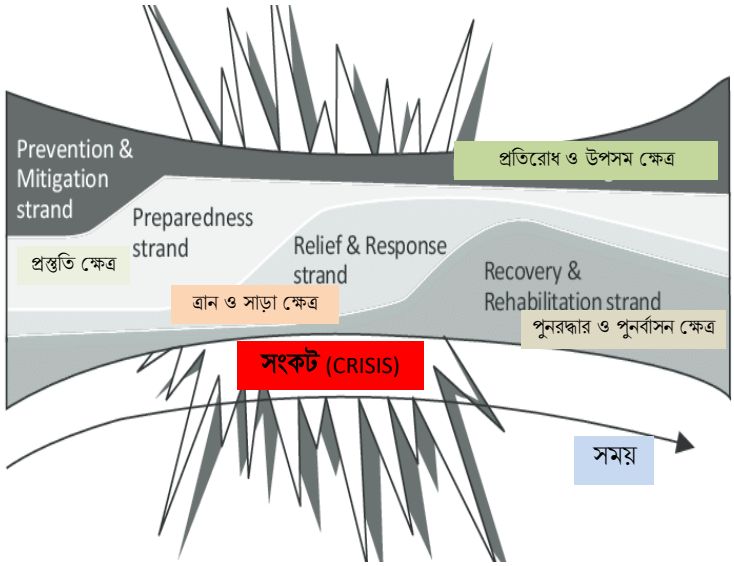


Figure 21: Expand – Contract Model (ADPC, n.d).

দুর্যোগ ব্যবস্থাপনা:চাপ ও চাপ-মুক্তি মডেল (Pressure and Release model)

চাপ ও চাপ-মুক্তি মডেল (Pressure and Release model)

- এই মডেলের কাঠামোর আলোকে দুর্যোগের সূত্র বা কারন সম্পর্কিত বিশ্লেষণ করা হয়। দুর্যোগের কারন ও প্রভাব সম্পর্কের পটভূমিতে এই মডেলটি উপস্থাপিত হয়েছে।
- এখানে বিপদাপন্নতার মূল কার্যকারণ আর্থসামাজিক ও রাজনৈতিক প্রক্রিয়ার গভিরে বিস্তৃত বলে মনে করা হয়
- দুর্যোগ ঝুঁকি হ্রাস করতে হলে এই সকল আর্থ সামাজিক ও রাজনৈতিক বিষয়ে দৃষ্টি দিতে হবে।
- এখানে একদিকে দেখা হয় দুর্যোগের মাত্রা ও অন্য পাশে থাকে সামাজিক, অর্থনৈতিক, রাজনৈতিক নিয়ামক সমূহ যা বিপদাপন্নতা আরও বৃদ্ধি করে। এই দ্বিমুখী চাপ ও চাপ- মুক্তি এই মডেলের আলোচ্য বিষয়ক্রম (Wisner, B etal, 2003).

দুর্যোগ ব্যবস্থাপনা:চাপ ও চাপ-মুক্তি মডেল (Pressure and Release model)

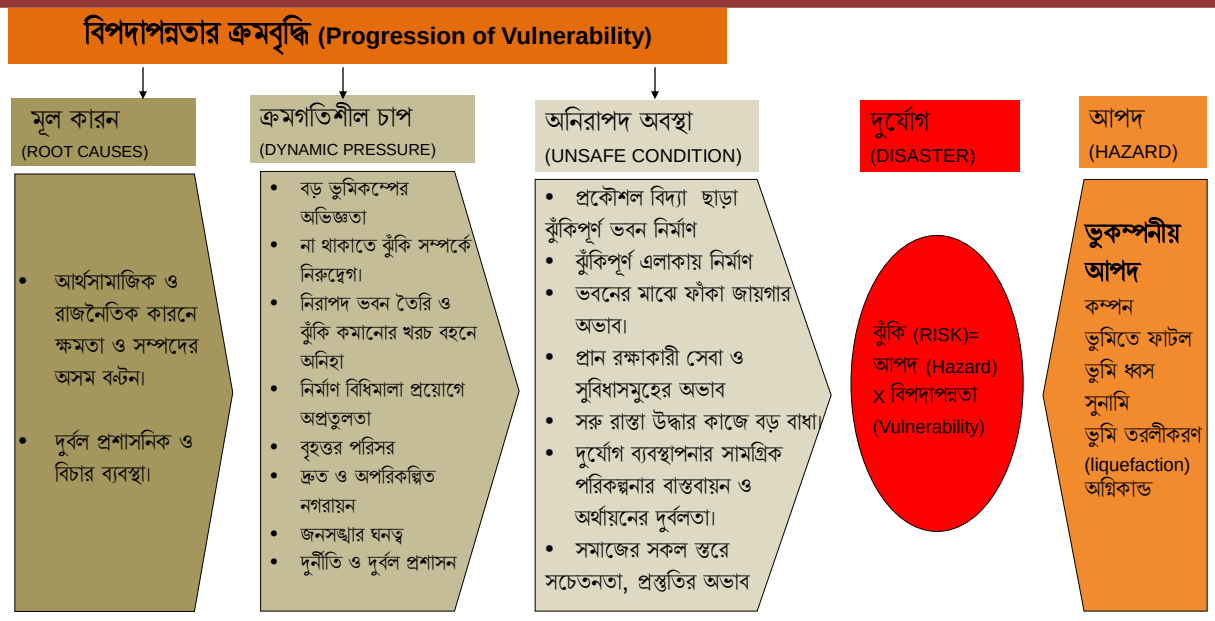


Figure 22: Pressure and Release model in relation to earthquake (Wisner et al., 2003)

ভূমিকম্প প্রস্তুতিকালে লক্ষণীয় বিষয় সমূহ

ভূমিকম্পের ঝুঁকি নিরুপন (Earthquake risk assessment)

- ✓ ভুকম্পণীয় আপদ নিরুপন (Earthquake hazard assessment)
- ✓ ভুমিকম্পের বিপদাপন্নতা নিরুপন (Earthquake vulnerability assessment)
  - — ভৌত কাঠামোর বিপদাপন্নতা নিরুপন (Physical vulnerability assessment)
  - — সামাজিক বিপদাপন্নতা নিরুপন (Social vulnerability assessment)
  - — প্রান রক্ষাকারি ও জরুরী অবকাঠামোর বিপদাপন্নতা নিরুপন (Lifeline and critical infrastructure vulnerability assess)
- ✓ ভূমিকম্প মোকাবেলায় সক্ষমতা নিরুপন (Earthquake capacity assessment)

- দুর্যোগ ব্যবস্থাপনা সংক্রান্ত জাতীয় নীতিমালা ও পরিকল্পনা সমন্ধে অবগত হওয়া।
- শহর ও এলাকা ভিত্তিক ভূমিকম্প ব্যবস্থাপনা বিষয়ে অবগত হওয়া।
- ঝুকি নিরুপনের পদক্ষেপ সমূহ বিশ্লেষণ করা এবং তাদের কার্যকারিতা পরিক্ষা করা।
- স্থানীয় জনগনের সচেতনতা বিশ্লেষণ করা।
- এই সকল বিষয় লক্ষ্য রেখে এলাকা ভিত্তিক আপদকালিন পরিকল্পনা প্রনয়ন।

ধন্যবাদ

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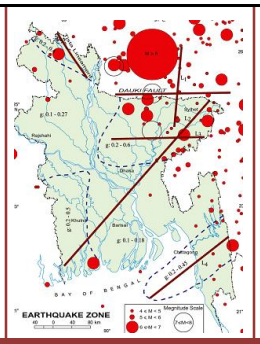

Lesson Two

Earthquake Vulnerability Assessment

Conducted by
BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS),
Department of Urban and Regional Planning
Department of Civil Engineering
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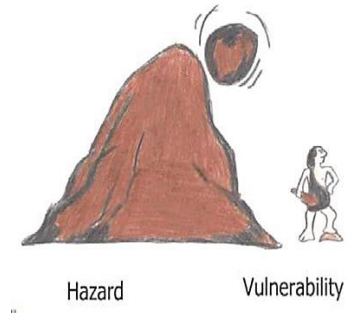
About the Lesson

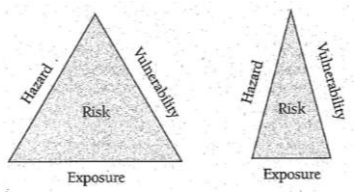
Topics Included:

- Concept of vulnerability
- Types of vulnerabilities
- Social vulnerability
- RVS (Rapid Visual Screening)
- DEA (Detailed Engineering Assessment)
  - Sub-structure assessment
  - Super-structure assessment
- Analysis Procedure
- Critical infrastructure and lifeline vulnerability

Concept of Vulnerability

- The propensity of exposed elements (such as physical or capital assets, as well as human being and their livelihoods) to experience harm and suffer damage when impacted by single or compound hazard event (Birkmann et al, 2013).
- It is a condition or sets of conditions that reduces people's ability to prepare for, withstand or respond to a hazard.
- It implies a measure of risk associated with the physical, social and economic aspects.
- Disaster Risk = $\frac{Hazard\ x\ Exposure\ x\ Vulnerability}{Capacity}$





Concept of Vulnerability

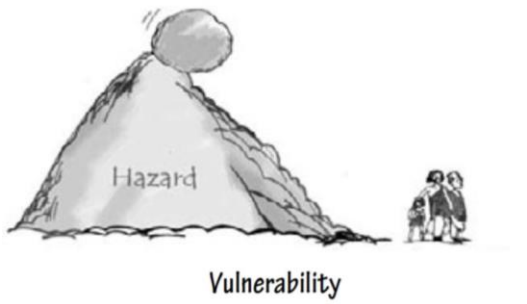
- The probability of earthquake in Dhaka could be lower than other hazards.
- Still if a shallow, high-magnitude earthquake hits Dhaka, the consequences would be devastating due to structural condition and population density.
- The areas where structural density is lower, adequate open spaces exist for shelters and people are aware about earthquake preparedness, the consequences would not be so baleful.
- So to assess the vulnerability, local geography, structural condition and population characteristics are important factors.

Types of Vulnerabilities

- **Structural Vulnerability**: Like irregularities (vertical irregularity, plan irregularity) in buildings that makes it potentially seismically hazardous.
- **Non-Structural Vulnerability:** Like adjacency issues (potential hazard from adjacent building) or any potential exterior falling hazards (unsupported water tank, unsupported parapet, chimney etc.)
- **Social Vulnerability:** The condition of exposed elements (human being and their livelihoods), to experience harm and suffer damage and loss when impacted by hazard events

Social Vulnerability

- Social vulnerability refers to potential harm to people.
- It involves a combination of factors that **determine the degree** to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society.
- The households with **direct access to capital, tools and equipment, and able-bodied members** are the ones which can recover most quickly when a disaster strikes.



Source: Center for Disaster Response, 2010

Social Vulnerability

Figure: Japan earthquake 2011

Figure: Nepal earthquake 2015

Importance of Social Vulnerability Assessment

- By including social vulnerability in our understanding of disaster risk, we acknowledge that disaster risk not only depends on the severity of hazard but also the susceptibility of people and economic assets to suffer loss and damage.
- At the event of any disaster, **local community** bear the main burden.
- As the **complex contexts of local people** varies significantly from community to community, it is logical to understand these complex contexts.
- Understanding social vulnerability helps to develop **adaptive and coping capacity** and thereby leads to community resilience at the local levels.
- It is also a critical factor to efficiently implement **mitigation and disaster preparedness** measures.

Difference between Physical and Social Vulnerability

Physical Vulnerability	Social Vulnerability
1. Considers the weakness of the buildings or structures	1. Considers the weakness of community living within the buildings
2. Explores if the building has been designed and constructed as per the prevailing code	2. People, households, community and their ways of life are explored to understand the vulnerability
3. The vulnerability can be reduced through structural strengthening or retrofitting	3. The vulnerability can be reduced through community awareness and capacity building

Determinants of Social Vulnerability Assessment

- ✓ **Demographic factors**: Gender, Age, Disability, Household income, Occupation, Asset ownership etc.
- ✓ **Social stratification:** Social status based on wealth, political leadership, race, ethnicity etc.
- ✓ **Literacy rates:** Education level, Household awareness about earthquake, Community awareness about earthquake etc.
- ✓ **Family type:** Nuclear family, Extended family etc.
- ✓ **Social capital:** Household relation, social interaction, duration of stay in the locality etc.
- ✓ **Cohesion within community:** Community Based Organizations (CBO), Community groups etc.

Who are Actually Vulnerable?

Based on	Vulnerability
Gender	**Women are more vulnerable** to disasters due to their responsibilities toward other members of the family (Rahman 1996; Teo et al. 2018)
Age group	• **Children and older people** are most vulnerable (Ainuddin and Routray 2012; Cutler et al. 2018; Doocy et al. 2013; Freeman et al. 2015; Isa et al. 2018) • **Young people** can greatly contribute to enhance community resilience; reducing vulnerability (Back et al. 2009; Freeman et al. 2015; Haynes and Tanner 2015)
Education level	People with **higher education are less vulnerable** (Ho et al. 2008)
Ownership	**Tenants** stay in an area for temporarily and **lack the sense of responsibility** which leads to increased community vulnerability (Ainuddin and Routray 2012)

Data Requirement for Social Vulnerability Assessment

Context	Issues
Awareness	• Acknowledgment about earthquake awareness • Source of knowledge of the people about earthquake • What knowledge people have • Knowledge about response to earthquake • Actual response of people remembering past earthquake experience • Knowledge about the existence of the Ward Disaster Management Committee in their area etc.
Perception	• Perception about earthquake vulnerability of the area and building they are residing in. • Perception about reasons of earthquake vulnerability of the area and the building etc.
Personal context	Gender, age, educational level, Building ownership status etc.
Social capital	Social interaction, Duration of stay in the locality etc.

Structural Vulnerability

- Structural Vulnerability refers to any weakness of the structure (like buildings) that can be exploited by any aggressor (like earthquake) or, in a non-terrorist threat environment, make that structure susceptible to hazard damage.
- An identified vulnerability may indicate that an asset (like structure):
  - ✓ is vulnerable to more than one threat or hazard.
  - ✓ and the mitigation measures may reduce vulnerability to one or more threats or hazards.
- To assess structural vulnerability followings are done
  - ✓ Visual Assessment (Rapid Visual Screening)
  - ✓ Detailed Engineering Assessment

RVS (Rapid Visual Survey)

- Procedure developed to identify, inventory, and screen buildings that are potentially seismically hazardous
- Uses a methodology based on a sidewalk survey of a building and a Data Collection Form
- Scores are calculated based on visual observation of the building from the exterior, and if possible, the interior.

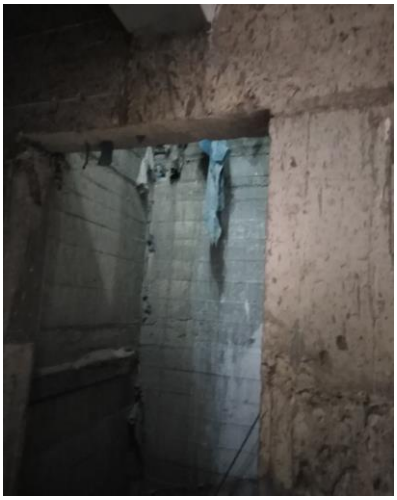
Guideline:

FEMA P-154 Report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*

Building Types

- According to FEMA different building types have been defined
  - C2: Concrete Shear Wall Buildings
  - C3: Concrete Frame with Unreinforced Masonry Infill Walls
  - URM: Unreinforced Masonry Buildings
  - S1: Steel Moment Resisting Frame
  - S2: Braced Steel Frame
  - S3: Light Metal Buildings
  - S5: Steel Frame with Unreinforced Masonry Infill Walls
  - W1: Light Wood Frame
- Different scorings are done based on this typology

C2: Concrete Shear Wall Buildings



C3: Concrete Frame with Unreinforced Masonry Infill Walls

URM: Unreinforced Masonry Buildings

S1: Steel Moment Resisting Frame

S2: Braced Steel Frame

S3: Light Metal Buildings

S5: Steel Frame with Unreinforced Masonry Infill Walls

W1: Light Wood Frame

Building Irregularities

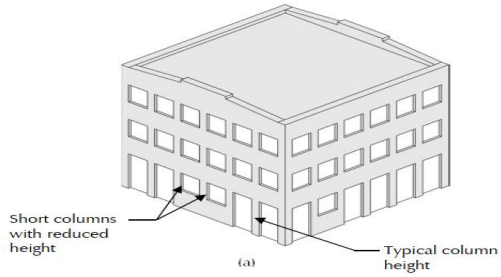
- Regular Structures
- Irregular Structures

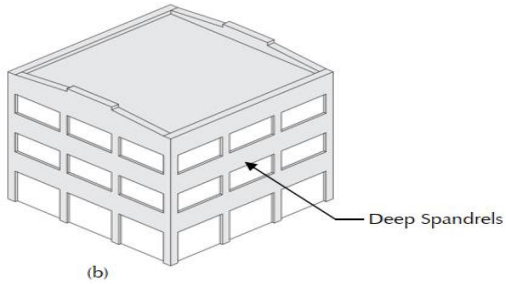
- Vertical Irregularity
  - Stiffness Irregularity (Soft Story)
  - Mass Irregularity
  - Vertical Geometric Irregularity
  - In-Plane Discontinuity
  - Discontinuity in Capacity (Weak Story)

- Plan (Horizontal) Irregularity
  - Torsional Irregularity
  - Reentrant Corners
  - Diaphragm Discontinuity
  - Out-of-Plane Offsets
  - Non-Parallel System

Severe Vertical Irregularities

1. Short Column

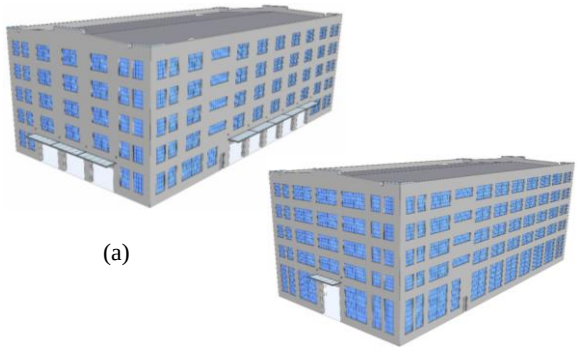




Short column due to a) reduced height, b) deep spandrels, c) partially infill walls

Severe Vertical Irregularities

2. Weak Storey/Soft Storey



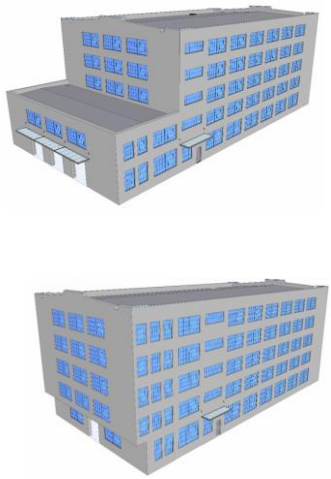
(a)

(b)

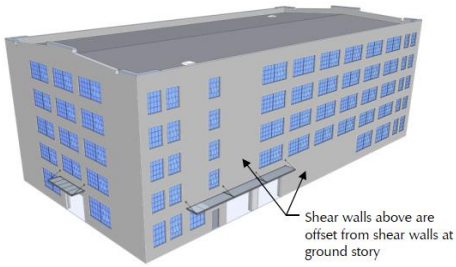
Weak Storey due to a)one of the stories has fewer walls and columns, b) one of the stories is tall compared to others

Severe Vertical Irregularities

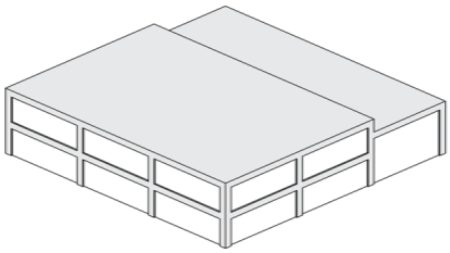
3.Out-of-Plane Setback



Moderate Vertical Irregularities



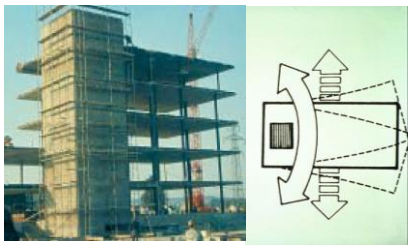
1. In-Plane Setback



2. Split Level

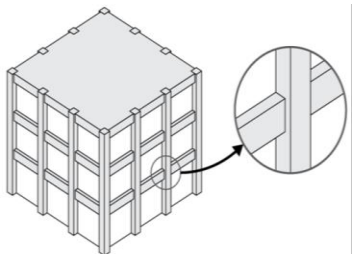
3. Sloping Site

Plan Irregularities

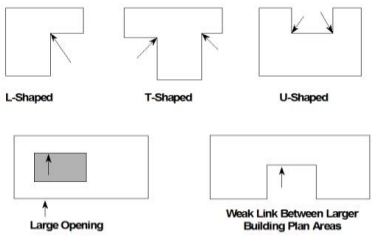


1. Torsional Irregularity

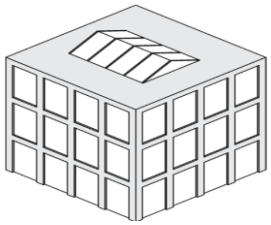
2. Non Parallel System



3. Out of plan offset

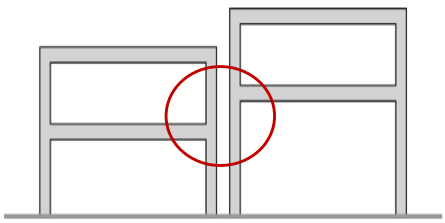


4. Reentrant Corner

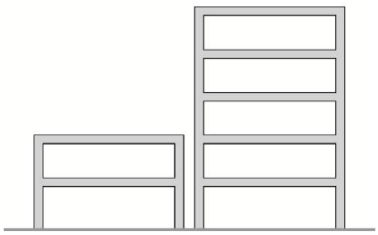


5. Diaphragm Openings

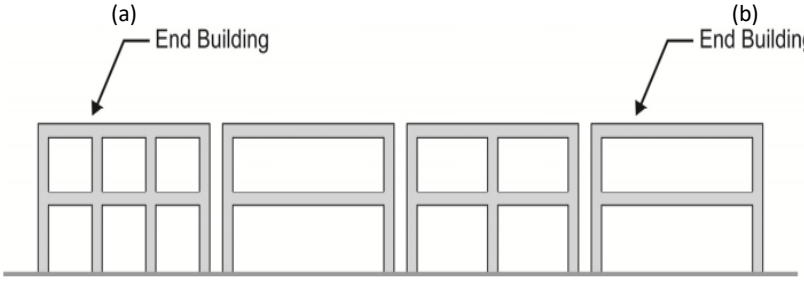
Pounding Potential



(a)



(b)



(c)

Non-Structural Vulnerability

Falling Hazards from taller adjacent buildings

Unsupported Water Tank

Unsupported Parapet

Cornices

Heavy Cladding

Masonry Tower

Chimney

Scoring

Region of Seismicity	High (Zone III)			Moderate (Zone II)			Low (Zone I)		
Build. Type	MRF	SW	M Inf	MRF	SW	M Inf	MRF	SW	M inf
Basic Score	2.5	2.8	1.6	3.0	3.6	3.2	4.4	4.8	4.4
Mid rise 4-7 storeys	+ 0.4	+ 0.4	+ 0.2	+ 0.2	+ 0.4	+ 0.2	+ 0.4	- 0.2	- 0.4
High rise >7 storeys	+ 0.6	+ 0.8	+ 0.3	+ 0.5	+ 0.8	+ 0.4	+ 1.0	0.0	- 0.4

Scoring (contd)

Effects of Irregularities on RVS Score

Region of Seismicity	High (Zone III)			Moderate (Zone II)			Low (Zone I)		
Build. Type	MRF	SW	M Inf	MRF	SW	M Inf	MRF	SW	M inf
Basic Score	2.5	2.8	1.6	3.0	3.6	3.2	4.4	4.8	4.4
Vertical Irregularity	- 1.5	- 1.0	- 1.0	- 2.0	- 2.0	- 2.0	- 1.5	- 2.0	- 2.0
Plan Irregularity	- 0.5	- 0.5	- 0.5	- 0.5	- 0.5	- 0.5	- 0.8	- 0.8	- 0.8

Scoring (contd)

Effect of Ductility

Region of Seismicity	High (Zone III)			Moderate (Zone II)			Low (Zone I)		
Build. Type	MRF	SW	M Inf	MRF	SW	M Inf	MRF	SW	M inf
Basic Score	2.5	2.8	1.6	3.0	3.6	3.2	4.4	4.8	4.4
Pre-code	- 1.2	- 1.0	- 0.2	- 1.0	- 0.4	- 1.0	N/A	N/A	N/A
Post-benchmark	+ 1.4	+ 2.4	N/A	+ 1.2	+ 1.6	N/A	+ 0.6	+ 0.4	N/A

Scoring (contd)

Effect of Soil Type

Region of Seismicity	High (Zone III)			Moderate (Zone II)			Low (Zone I)		
Build. Type	MRF	SW	M Inf	MRF	SW	M Inf	MRF	SW	M inf
Basic Score	2.5	2.8	1.6	3.0	3.6	3.2	4.4	4.8	4.4
Soil Type C	-0.4	-0.4	-0.4	-0.6	-0.8	-0.6	-0.6	-0.4	-0.4
Soil Type D	-0.6	-0.6	-0.4	-1.0	-1.2	-1.0	-1.4	-0.8	-0.8
Soil Type E	-1.2	-0.8	-0.8	-1.6	-1.6	-1.6	-2.0	-2.0	-2.0

Scoring (contd)

Final Score

S = BSH + SMs

If S<2, a detailed analysis is required

S=2 implies that there is a chance of 1 in 10^2 that the building will collapse

Ranking based on Seismic Assessment

RVS S<0.3	**Red**
RVS 0.3<S<0.7	Amber
RVS 0.7<S<2.0	Yellow
RVS S>2	Green

Detailed Engineering Assessment (DEA)

- A Detailed Engineering Assessment (DEA) is a detailed structural engineering investigation and reporting of a building structure
- Necessary when there is insufficient information and documentation on the building structure to determine the safety of the structure.
- Intrusive or destructive assessment is expected to be used during this detailed assessment.
- DEA includes:
  - Super structure Assessment
  - Sub-structure Assessment

Superstructure Assessment

- This includes inspection and testing of structural members (above ground) and their materials

- The following are included in this process
  - Preparation of as built drawing
  - Material strength determination
  - Checking reinforcements
  - Inspection of distress, excessive deformation, spalling, corrosion etc.

As-Built Drawing

As-built drawing should be generated in order to concisely record the general arrangement of the building and size and location of the structural elements.

As-built structural drawing set should include:

a. Foundation layout.
b. Ground floor layout.
c. First floor layout.
d. Additional floor layouts for each additional suspended floor or mezzanine including beam and column schedule and existing super- imposed dead loading.
e. Roof layout.
f. Building elevations.
g. Building sections.
h. CAD softcopy of As-built should be submitted along with DEA.
i. Scan Report of structural members with As Built Structural Drawings.

Determination of Material Strength

Concrete

- Existing concrete strength should be determined using 100mm diameter concrete core to estimate strength capacity of all key structural elements.
- Cores are collected from structural members, e.g. concrete columns, beams and slabs
- ACI 562 can be used to evaluate concrete strength from core test results.
- Reliance on rebound hammer result should not be accepted.
- The use of CAPO testing can be considered in conjunction with core testing with the use of the correlation testing of concrete with reference to the aggregate type.

Determination of Material Strength

Brick

- Shear test of bricks in masonry structure for obtaining compressive strength of brick
- Prism test for obtaining compressive strength of brick mortar unit

Reinforcement

- The strength and type of reinforcement used in RC element should be determined by lab test
- Scanning of reinforced concrete element should be performed in order to determine the size/quantity/spacing of the reinforcement provided. All soft copies of the test result should be submitted along with DEA.

Scanning of Reinforced Concrete

- Apart from these any corrosion in reinforcement should be noted
- Spalling, excessive deformations, cracks should also be reported

Purpose of Substructure Assessment

- Identify the nature of deposit (type and thickness of soil layers)
- Assess the suitability of sub-soil for the anticipated loads (from building)
- Determine the location of ground water table and its variation
- Assess potential foundation problems (e.g. expansive soil, collapsible soil, liquefiable soil, ground settlement/heaving etc.)
- Decide on appropriate type of foundation and depths
- Determine the necessity, extent and process of ground improvement/ modification
- Collect soil samples to perform laboratory tests for soil characterization and determination of various appropriate design parameters.
- Decide on suitable construction methods and sequence of construction

Steps in soil investigation

- Collection of Background Information
- Field Reconnaissance
- Bore-hole Drilling
- Collection of Soil Samples
- Field Tests (SPT, CPT etc.)
- Laboratory Test on Soil Samples
- Preparation of Geotechnical Report

Soil boring and test pit

- Boring method
- Number of boring
- Boring Layout
- Boring depth
- Sampling specifications (interval, type etc.)

Boring Depth

- The approximate required minimum depth of the borings should be predetermined.
- The depth can be changed during the drilling operation, depending on the subsoil encountered.

No. of Stories	Boring Depth	
	(m)	(ft)
1	3.5	11
2	6	20
3	10	33
4	16	53
5	24	79

- Disturbed and undisturbed samples need to be collected from boreholes for further laboratory tests
- The samples must be representative (disturbed or undisturbed)

Field Tests/In-Situ Tests

- Standard Penetration Test
- Vane Shear Test
- Cone Penetrometer Test
- Pressuremeter Test
- Dilatometer Test
- Dynamic Penetration Tests (DPL, DPM, DPH, DPSH)

Most practiced method in Bangladesh is Standard Penetration Test

Standard Penetration Test (SPT)

➢ *Advantage:*

- Simple equipments
- Low cost
- Do not require much expertise for field operations
- Disturbed samples are collected

➢ *Disadvantage:*

Much variation in the results (i.e. poor repeatability)

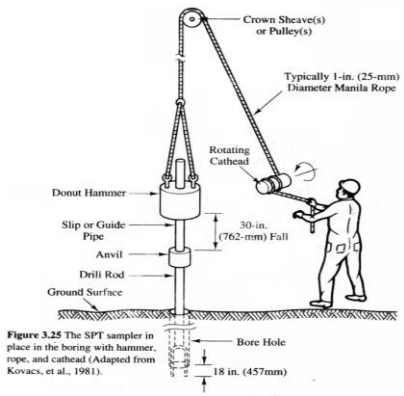


Figure 3.25 The SPT sampler in place in the boring with hammer, rope, and cathead (Adapted from Kovacs, et al., 1981).

Standard Penetration Test (SPT) (contd)

It was regularly observed that N values in adjacent boreholes or from using different equipment in adjacent boreholes were not reproducible.

The variation in N value arises from

1. Equipment from different manufacturers
2. Drive hammer configuration (Donut/Safety hammer/Auto trip
3. Actual Drop height (variation in manual/auto trip operation)
4. Rope cat-head system : dia and condition (rusty/clean) of rope, no. of turns ($1^1/_2$, 2, 3 etc.)
5. Use of liner inside the split barrel (usually liner is not used)
6. Overburden pressure – soil of the same density will give smaller N value if p'_0 is smaller; oversize borehole (> 150 mm will also reduce the N value
7. Length of drill rod- (if rod length > 10 m – not critical; for shorter lengths and N<30 it is critical)
8. Rate at which blow is applied; sometimes drilling crew are more interested in advancing the hole quickly (30 ~40 blow per min. is recommended)
9. Diameter of the drill hole
10. Presence or lack of drilling mud

Cone Penetration Test (CPT)

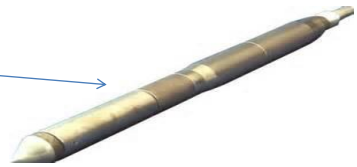
- The cone penetrometers in use at present measure

a) The *cone resistance (q_c) to* penetration developed by the cone, which is equal to the vertical force applied to the cone divided by its horizontally projected area, and

b) The *frictional resistance (f_c),* which is the resistance measured by a sleeve located above the cone with the local soil surrounding it. The frictional resistance is equal to the vertical force applied to the sleeve divided by its surface area.

c) It is currently emerging as a new method for sub-soil investigation

Photograph of a cone penetrometer



Cone Penetration Test (CPT) (contd)

Advantage of CPT

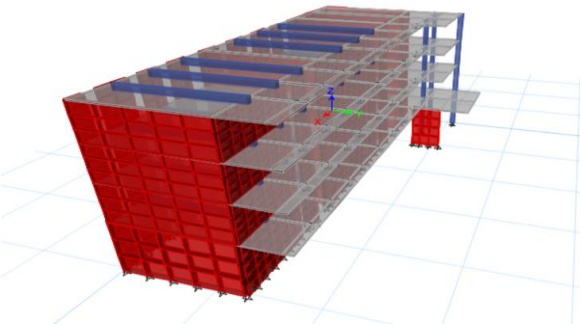
- CPT is a useful means to determine the soil profile. Since it retrieves data continuously with depth (with electric cone) or at very close interval (with mechanical cone), CPT can detect thin layers in stratigraphy. Sometimes use of CPT in the first phase facilitate better specification for boring and sampling in the second phase.
- It is also less prone to error due to automated operation of the equipment and electronic data recording.

Disadvantage of CPT

- No soil sample is recovered. So no opportunity to inspect the soils.
- The test is unreliable or unusable in soils with significant gravel content.
- Although the cost per foot of penetration is less than that for borings, it is necessary to mobilize a special rig to perform the CPT. CPT at a certain site may not be possible from the point of equipment mobilization.

Analysis

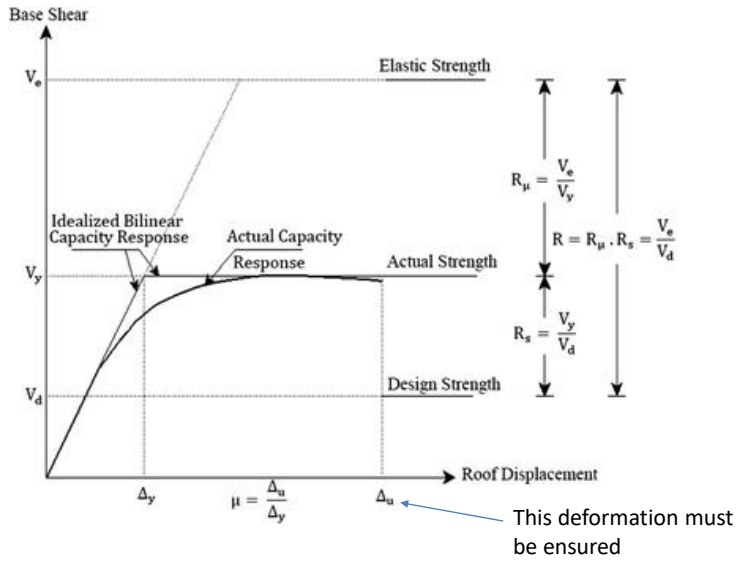
- After data collection and testing a structural model of the building should be developed
- It is done using an international recognized computer analysis package e.g. Etabs
- Final analysis shows the structural adequacy of all the members using concrete compressive strength/rebar strength of composite section (old/new concrete/rebar)
- The results are interpreted to comment on the overall vulnerability status of the structure



Model generated in Etabs

Earthquake Resistant Design

The philosophy of Earthquake Resistant Design (ERD) is based on ductility. Concrete is a brittle material. Ductility is imparted in concrete structures by ductile steel.

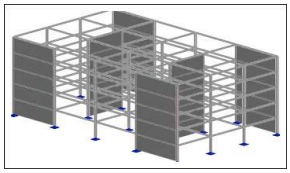


Response Modification Factor

Seismic Force–Resisting System	Response Reduction Factor, R
A. BEARING WALL SYSTEMS	
1. Special reinforced concrete shear walls	5
2. Ordinary reinforced concrete shear walls	4
B. BUILDING FRAME SYSTEMS	
5. Special reinforced concrete shear walls	6
6. Ordinary reinforced concrete shear walls	5
C. MOMENT RESISTING FRAME SYSTEMS	
4. Special reinforced concrete moment frames	8
5. Intermediate reinforced concrete moment frames	5
6. Ordinary reinforced concrete moment frames	3
D. DUAL SYSTEMS: SPECIAL MOMENT FRAMES	
3. Special reinforced concrete shear walls	7
4. Ordinary reinforced concrete shear walls	6
E. DUAL SYSTEMS: INTERMEDIATE MOMENT FRAMES	
2. Special reinforced concrete shear walls	6.5
4. Ordinary reinforced concrete shear walls	5.5
F. DUAL SHEAR WALL-FRAME SYSTEM: ORDINARY REINFORCED CONCRETE MOMENT FRAMES AND ORDINARY REINFORCED CONCRETE SHEAR WALL	4.5

Basic Structural Systems

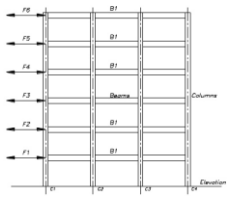
- Bearing Wall System: Bearing walls/bracing systems without a complete vertical load carrying frame to support gravity loads. Resistance to lateral loads is provided by shear walls or braced frames.
- Building Frame System: Complete space frame providing support for gravity loads. Resistance to lateral loads is provided by shear walls or braced frames separately.
- Moment Resisting Frame System: Complete space frame providing support for gravity loads. Moment resisting frames also provide resistance to lateral load primarily by flexural action of members.

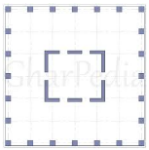


Basic Structural Systems

- Moment Resisting Frames
  - Special Moment Frames
  - Intermediate Moment Frames
  - Ordinary Moment Frames
- Dual System: Combination of moment resisting frames and shear. walls or braced frames. The moment resisting frames shall be capable of resisting at least 25% of the applicable total seismic lateral force.
- Special Structural System: Not defined above such as tube-in-tube, bundled tube etc.

Moment resisting frames





Analysis Procedure

- Equivalent Static Analysis
- Dynamic Analysis

➢ Regular buildings with height greater than 40 m in Zones 2, 3, 4 and greater than 90 m in Zone 1

➢ Irregular buildings with height greater than 12 m in Zones 2, 3, 4 and greater than 40 m in Zone 1

➢ Several aspects are considered for the analysis

Occupancy Category

Nature of Occupancy	Occupancy Category
Low Hazard	I
Other than categories I, III or IV	II
Substantial hazard if failure	III
Essential facilities	IV

Site Class

Soil Type	Description	V_s / N
SA	Rock like	$V_s > 800$
SB	Very dense sand / Very stiff clay	$360 > V_s > 800$; $N > 50$
SC	Dense sand / Stiff clay	$180 > V_s > 360$; $15 > N > 50$
SD	Loose to medium dense sand / soft to firm clay	$V_s < 180$; $N > 15$
SE	5 m to 20 m alluvium above rock	-

Seismic Design Category

Site Class	Occupancy Category I, II and III			
	Zone 1	Zone 2	Zone 3	Zone 4
SA	B	C	C	D
SB	B	C	D	D
SC	B	C	D	D
SD	C	D	D	D
SE, S_1, S_2	D	D	D	D

Height Limitation

Seismic Force–Resisting System	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
	Height limit (m)		
C. MOMENT RESISTING FRAME SYSTEMS (no shear wall)			
1. Special steel moment frames	NL	NL	NL
2. Intermediate steel moment frames	NL	NL	35
3. Ordinary steel moment frames	NL	NL	NP
4. Special reinforced concrete moment frames	NL	NL	NL
5. Intermediate reinforced concrete moment frames	NL	NL	NP
6. Ordinary reinforced concrete moment frames	NL	NP	NP

Seismic Considerations

Special Considerations for Loading

- Seismic weight
- Horizontal torsional moments
- P-Delta effects
- Simultaneous loading in principal directions
- Vertical earthquake loading

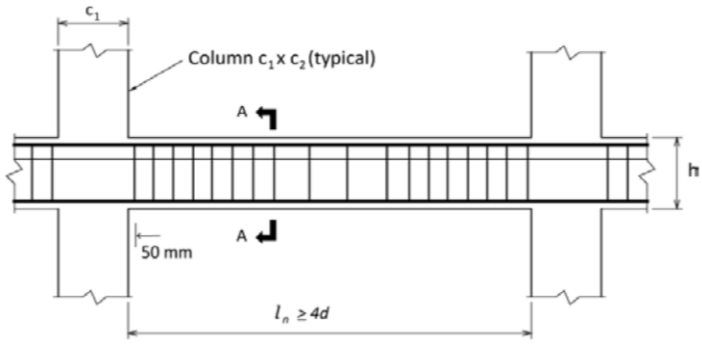
Seismic Detailing

- SDC D structures shall satisfy the requirements of special seismic detailing as given in Sections 8.3.3 to 8.3.8
- SDC C structures shall be built to satisfy the requirements of intermediate seismic detailing as given in Sec 8.3.10
- SDC B structures shall be built to satisfy the requirements of ordinary detailing as given in Sec 8.3.9

Requirements of SDC D

$f_c' \geq 21$ MPa $\qquad$ $f_y \leq 420$ MPa $\qquad$ $f_u \geq 1.25 f_y$

- Flat slab is not permitted.
- Welding is not permitted on stirrups and ties.



$$\sum M_c \geq 1.2 \sum M_b$$

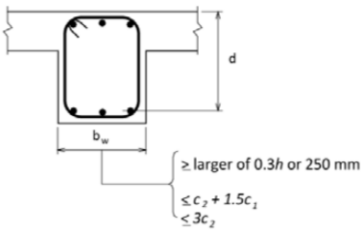


Table 6 — Tensile properties

Ductility class	Steel grade	Specified characteristic value of upper yield strength R_{eH} MPa [c]		Ductility properties: Specified characteristic value of R_m/R_{eH}	Ductility properties: Specified characteristic value of elongation [a] %	
		Minimum	Maximum	Minimum	A Minimum	A_{gt} Minimum
A	B300A-R	300	—	1,02	16	2
	B400A-R B400AWR	400	—		14	
	B500A-R B500AWR	500	—			
	B600A-R	600	—		10	
	B450AWR	450	1,25 × R_{eH}(min.)	1,05	-	2,5
B	300B-R	300	—	1,08	16	5
	B400B-R B400BWR	400	—		14	
	B500B-R B500BWR	500	—			
	B600B-R	600	—		10	
C	B300C-R	300	—	1,15	16	7
	B400C-R B400CWR	400	—		14	
	B500C-R B500CWR	500	—			
	B600C-R	600	—		10	
	B450CWR	450	1,25 × R_{eH}(min.)		-	7,5
D	B300D-R	300	—	1,25	17 [b]	8
	B300DWR		1,3 × R_{eH}(min.)			
	B350DWR	350				
	B400DWR	400				
	B420DWR	420			16 [b]	
	B500DWR	500			13 [b]	

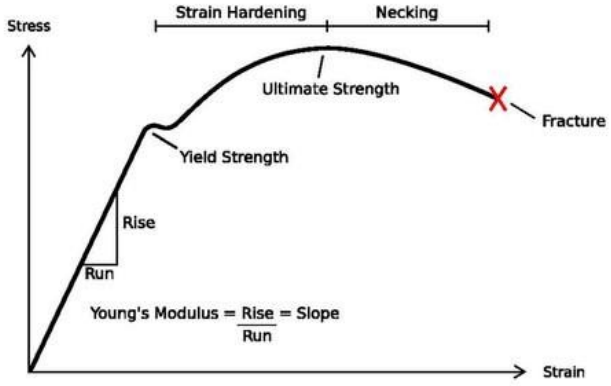
[a] By agreement between the manufacturer and purchaser, the type of elongation shall be selected between A and A_{gt}. If the type of elongation is not specified by agreement, A_{gt} should be used.

[b] In the case of the bars with diameter 32 mm or more in ductility class D, the minimum specified characteristic value for A may be decreased by 2 % for each 3 mm increase in diameter. However, the maximum diminution from the minimum specified characteristic value stated in Table 6 is limited to 4 %.

[c] 1 MPa = 1 N/mm²

Ductility of Steel

BDS ISO 6935-2-2016

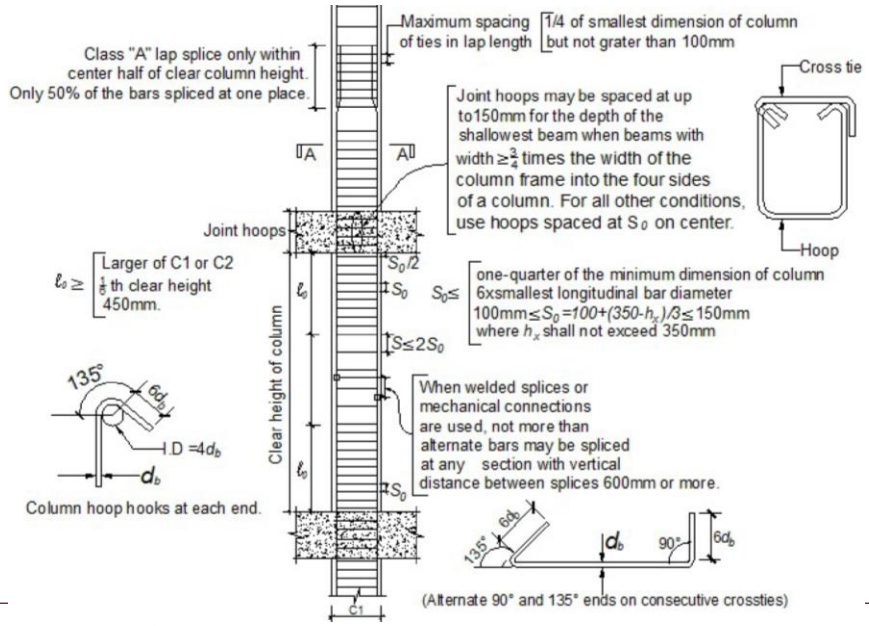


63

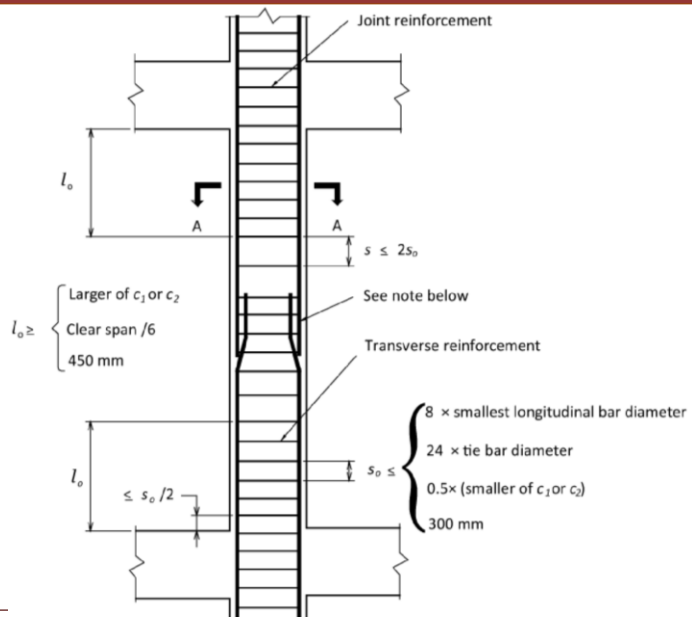
ACI 318-19

- Starting with ACI 318-19, ASTM A706 Grades 80 and 100 reinforcement is permitted to resist moments, axial, and shear forces in special structural walls and all components of special structural walls, including coupling beams and wall piers.
- ASTM A706 Grade 80 reinforcement is also permitted in special moment frames.
- The use of Grade 100 reinforcement is not allowed in special moment frames because there is insufficient data to demonstrate satisfactory seismic performance.
- ASTM A615 Grade 80 and Grade 100 are not permitted in special seismic systems.

Column Tie Detailing of SDC D



Column Tie Detailing of SDC C



Social Vulnerability

Definition of Social Vulnerability

- Social vulnerability is defined as "… the propensity of exposed elements (human being and their livelihoods), to experience harm and suffer damage and loss when impacted by single or compound hazard events…"(Birkmann et al, 2013).
- Social vulnerability refers to potential harm to people. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society.

Figure 18: Women at Nepal earthquake

Social Vulnerability

Importance of Social Vulnerability

- By including vulnerability in our understanding of disaster risk, we acknowledge the fact that disaster risk not only depends on the severity of hazard or the number of people or assets exposed, but that it is also a reflection of the susceptibility of people and economic assets to suffer loss and damage.
- As the complex contexts of local people varies significantly from community to community, it is logical to understand these complex contexts i.e. personal contexts, social capital, power structure, and people's awareness, knowledge and perception about the risk etc. so that the sets of conditions that reduces people's ability to prepare for, withstand or respond to earthquake can be assessed.
- Understanding social vulnerability helps to develop adaptive and coping capacity utilizing people's own physical and psychological assets and thereby leads to community resilience at the local levels
- It is also a critical factor to efficiently implement mitigation and disaster preparedness measures (Barua et al., 2020)

Social Vulnerability

Difference between Physical and Social Vulnerability

Physical Vulnerability	Social Vulnerability
1. Considers the weakness of the buildings or structures	1. Considers the weakness of community living within the buildings
2. Explores if the building has been designed and constructed as per the prevailing code	2. People, households, community and their ways of life are explored to understand the vulnerability
3. The vulnerability can be reduced through structural strengthening or retrofitting	3. The vulnerability can be reduced through community awareness and capacity building

Social Vulnerability

Determinants of Social Vulnerability

- The following are the main factors that help to define the level of social vulnerability for earthquake:
  - ✓ **Demographic factors**, (i.e. Gender, Age, Disability, Household income, Occupation, Asset ownership etc.)
  - ✓ **Social stratification** (i.e. Social status based on wealth, political leadership, race, ethnicity etc.)
  - ✓ **Literacy rates** (i.e. Education level, Household awareness about earthquake, Community awareness about earthquake etc.)
  - ✓ **Family type** (i.e. Nuclear family, Extended family etc.)
  - ✓ **Social capital** (i.e. household relation, social interaction, duration of stay in the locality etc.)
  - ✓ **Cohesion within community** (i.e. Community Based Organizations (CBO), Community groups etc.)

Social Vulnerability

Who are Actually Vulnerable?

Based on	Vulnerability
Gender	Women are more vulnerable to disasters, because they cannot respond to disaster immediately and effectively due to their responsibilities toward other members of the family (Rahman 1996; Teo et al. 2018)
Age group	• Children and older people are most vulnerable due to their mobility and health issues (Ainuddin and Routray 2012; Back et al. 2009; Brunkard et al. 2008; Cutler et al. 2018; Doocy et al. 2013; Freeman et al. 2015; Isa et al. 2018) • Young people can greatly contribute to enhance community resilience; reducing vulnerability (Back et al. 2009; Freeman et al. 2015; Haynes and Tanner 2015)
Education level	People with higher education are less vulnerable through understanding the complexities of hazards more easily (Ho et al. 2008)
Ownership	Tenants stay in an area for temporarily and lack the sense of responsibility which leads to increased community vulnerability (Ainuddin and Routray 2012)

Social Vulnerability

Data Requirement for Social Vulnerability Assessment

Section	Factor
Awareness	• Acknowledgment about awareness of earthquake • Source of knowledge of the people considering themselves aware about earthquake • Knowledge of the people considering themselves aware about earthquake • Knowledge people possess about response at the event of an earthquake • Actual response of people remembering past earthquake experience • Knowledge about the existence of the Ward Disaster Management Committee in their area etc.
Perception	• Perception about earthquake vulnerability of the area and building they are residing in. • Perception about reasons of earthquake vulnerability of the area and the building etc.
Personal context	Gender, age, educational level, Building ownership status etc.
Social capital	Social interaction, Duration of stay in the locality etc.

(Source: Barua et al., 2020)

Critical Infrastructure and Lifeline Vulnerability

- It includes the assets, systems, facilities, networks, and other elements that society relies upon to maintain national security, economic vitality, and public health and safety.
- There are four designated lifeline functions- transportation, water, energy, and communications, which means that their reliable operations are so critical that a disruption or loss of one of these functions will directly affect the security and resilience of critical infrastructure within and across numerous sectors.
- For example, energy stakeholders provide essential power and fuels to stakeholders in the communication, transportation, and water sectors, and, in return, the energy sector relies on them for fuel delivery (transportation), electricity generation (water for production and cooling), as well as control and operation of infrastructure (communication).
- These connections and interdependencies between infrastructure elements and sectors mean that the loss of one or more lifeline function(s) typically has an immediate impact on the operation or mission in multiple sectors (CISA, 2019).

Critical Infrastructure and Lifeline Vulnerability

- Life lines infrastructure and critical facilities include basic urban services such as
  - ✓ Water supply
  - ✓ Sanitary drainage
  - ✓ Storm drainage
  - ✓ Electricity supply
  - ✓ Gas and oil supply
  - ✓ Telecommunication services
  - ✓ Road, highway and bridges
  - ✓ Railways
  - ✓ Airports

Critical Infrastructure and Lifeline Vulnerability

Components of critical infrastructure vulnerability assessment

- Functional component
  - ✓ Within an individual line, specific lifeline features
  - ✓ Dependency on other systems and lifelines.
  - ✓ Degree of functional dependency of emergency systems and other urban systems on lifelines
- Organizational component
  - ✓ Organization within each lifeline company, number of companies for each lifeline
  - ✓ Inter agencies cooperation
  - ✓ Cooperation among lifelines companies
- Physical component
  - ✓ Vulnerability of each lifeline
  - ✓ Physical vulnerability of lifeline essential for the function of other lifelines
  - ✓ physical vulnerability of systems which lifelines are physically connected (Menoni et al, 2002)

Critical Infrastructure and Lifeline Vulnerability

Factors needs to be considered to assess the vulnerability

- An understanding of the diversity of hazards and threats they could face.
- Infrastructure characteristics i.e. size, distribution that influence the effects of a disruption
- A consideration of the complexity of cross-sector connections
- Role and capability of different agencies and lifeline agencies and understanding their coordination network
- Understanding mutual interactions among lifelines, recognizing their intra-dependent and inter-dependent character
- Secondary and indirect consequences on the economy and on society in general due to services interruption (Menoni et al, 2002; Lewis & Petit, n.d)

Critical Infrastructure and Lifeline Vulnerability

Framework to assess the vulnerability

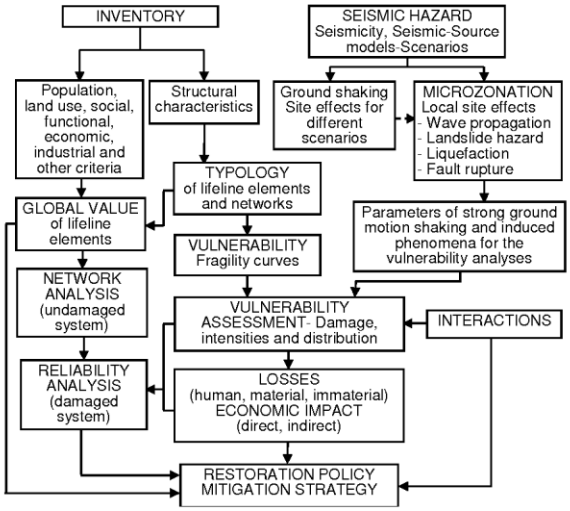


Figure 20: A framework for vulnerability assessment (Source: Pitilakis & Kakderi, 2011)

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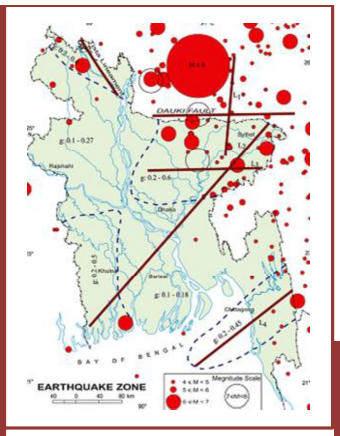
Thank You



Lesson Three

Earthquake Vulnerability Assessment

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About the Lesson

- Earthquake vulnerability assessment
- At the end of the lesson, we would learn
  - ✓Social vulnerability assessment: Data requirements and determinants
  - ✓Vulnerability of structures: Data requirements and Determinants
  - ✓Critical infrastructure and lifeline vulnerability: Concepts

Concept of Vulnerability

Figure: Effect of earthquake in village, Nepal
(Source: Santana, 2015)

Figure: Effect of earthquake in city, Mexico
(Source: Keneally, 2017)

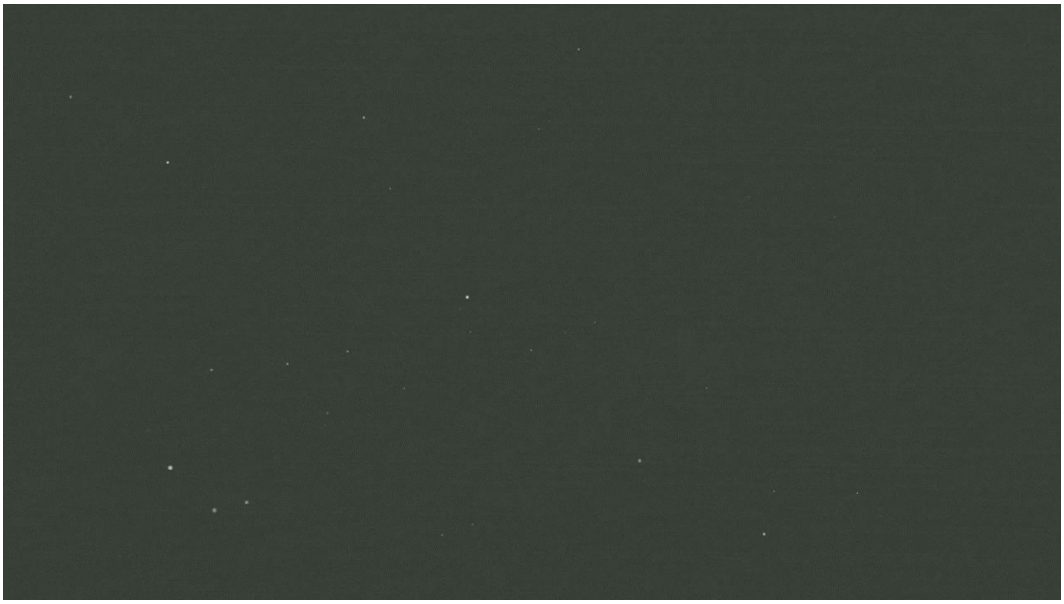
Concept of Vulnerability and Risk

- **RISK**
  - Hazard
  - Exposure
  - Vulnerability
  - Capacity

$$\uparrow \text{Disaster Risk} = \frac{\uparrow Hazrd \times \uparrow exposure \times \uparrow vulnerability}{capacity \downarrow}$$

$$\downarrow \text{Disaster Risk} = \frac{\downarrow Hazrd \times \downarrow exposure \times \downarrow vulnerability}{capacity \uparrow}$$

Concept of Vulnerability and Risk



For further understanding, please watch: Understanding Disaster Risk (GFDRR, 2016)
https://www.youtube.com/watch?v=0-SWl3J1aQc

Concept of Vulnerability and Risk

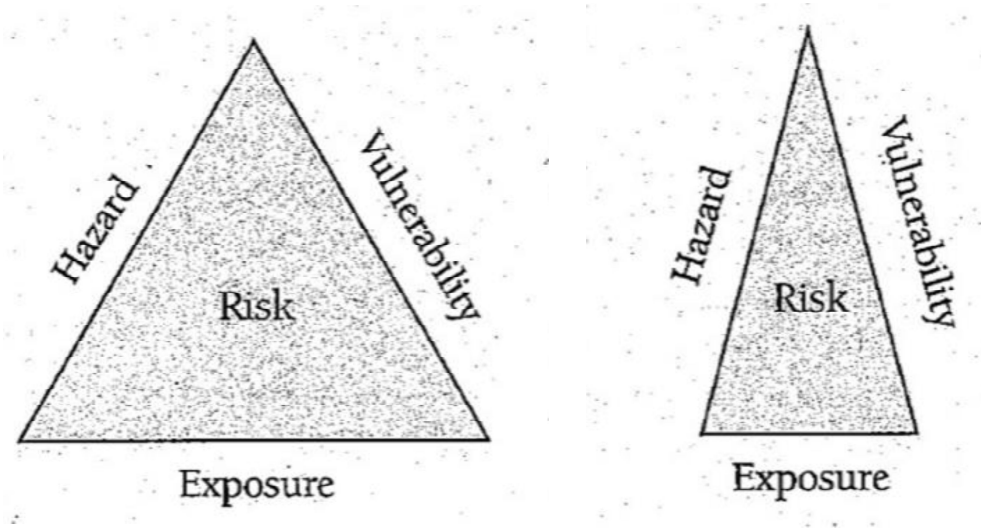


Figure: Risk Triangle
(Source: Crichton, 1999)

Concept of Vulnerability

- Birkmann et al (2013)
  - "… the **propensity** of exposed elements such as physical or capital assets, as well as human being and their livelihoods,
  - to experience harm and suffer damage and loss
  - when impacted by single or compound hazard events…"
- Wisner et al (2003)
  - "… the **characteristics** of a person or group and their situation
  - that influence their capacity to anticipate, cope with, resist and recover
  - from the impact of a natural hazard…"

Concept of Vulnerability

For further understanding, please watch:
What is vulnerability and how do we adapt to climate change? (GIZ-México, 2014)
https://www.youtube.com/watch?v=gRnvx75D0W8

Concept of Vulnerability

- Condition or sets of conditions that reduces people's ability to prepare for, withstand or respond to a hazard
- Associated with the physical, social and economic aspects

Importance of understanding vulnerability

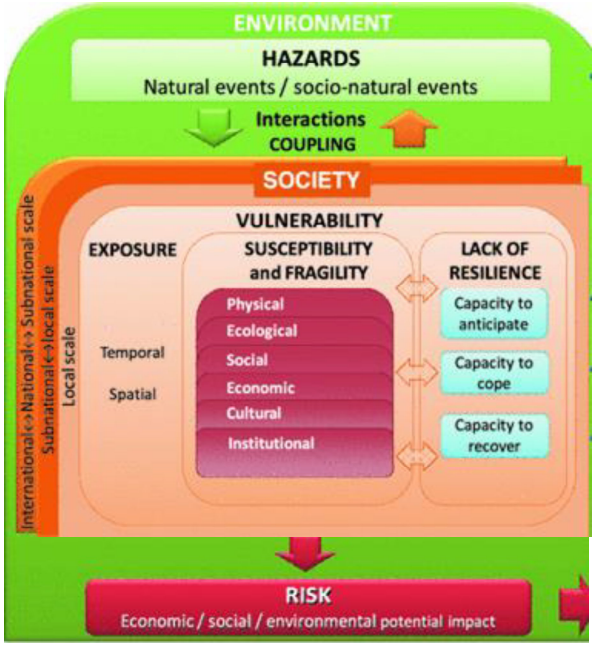


Figure: MOVE framework (Source: Birkmann et al., 2013)

Importance of understanding vulnerability

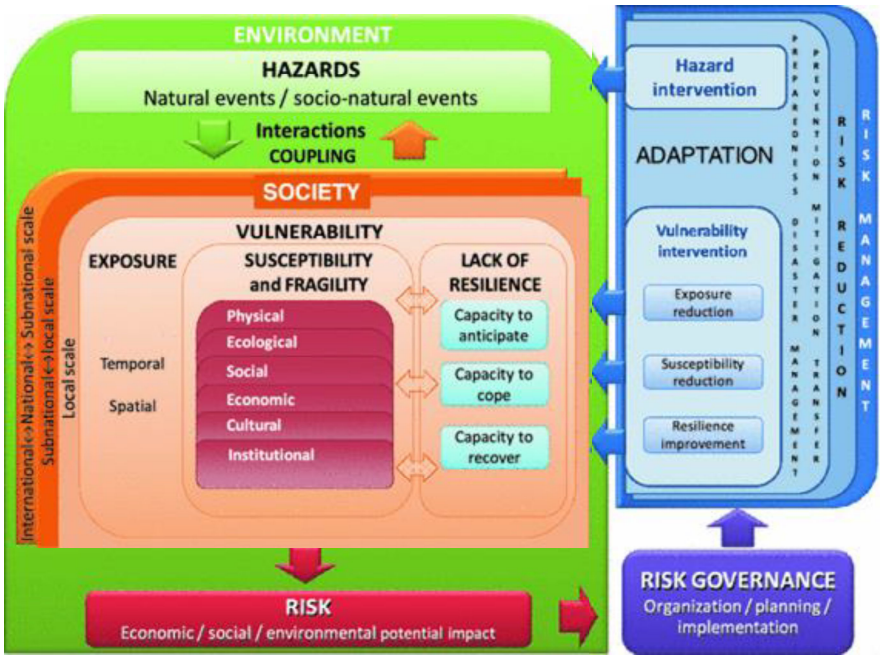


Figure: MOVE framework (Source: Birkmann et al., 2013)

Concept of Vulnerability

- Social Vulnerability
- Structural Vulnerability
- Non-Structural Vulnerability
- Critical Infrastructure and Lifeline Vulnerability

Social Vulnerability: Concept

- Social aspects of a person or group: Social, Economic, and Awareness and Preparedness
  - that influence their capacity to anticipate, cope with, resist and recover
  - from the impact of a natural hazard

Figure: Women and children at Nepal earthquake (Source: Crossan, 2015)

Social Vulnerability: Concept

Difference between Physical and Social Vulnerability

Subject of comparison	Physical Vulnerability	Social Vulnerability
1. Consideration	Weakness of the buildings or structures	Weakness of community living within the buildings
2. Subject to explore	Design and construction of building as per the prevailing code	People, households, community and their ways of life
3. Way to reduce vulnerability	Structural strengthening or retrofitting	Community awareness and capacity building

Social Vulnerability: Importance

- To **acknowledge the influence of social vulnerability** on risk by considering the susceptibility of people and economic assets to suffer loss and damage
- The complex contexts of local people **varies significantly from community to community**
- To **understand and assess these complex contexts** that influence people's ability to prepare for, withstand or respond to earthquake
- To **develop adaptive and coping capacity** utilizing people's own physical and psychological assets and thereby leads to community resilience at the local levels
- To efficiently **implement mitigation and disaster preparedness measures** (Barua et al., 2020)

Social Vulnerability Assessment: Data collection method

- Household questionnaire survey and/or participatory tool
- Further the vulnerability of various social groups are assessed from different perspectives analyzing the collected data.

Figure: Household questionnaire survey
(Source: BUET, 2018)

Figure: Focus group discussion
(Source: BUET, 2018)

Social Vulnerability Assessment: Determinants

- **Social**
- **Economic**
- **Awareness and preparedness**

Social Vulnerability Assessment: Determinants

- **Social**
  - ✓ **Demographic factors**, (i.e. Gender, Age, Disability, etc.)
  - ✓ **Literacy rates** (i.e. Education level, etc.)
  - ✓ **Social stratification** (i.e. Social status based on wealth, political leadership, race, ethnicity etc.)
  - ✓ **Family type** (i.e. Nuclear family, Extended family etc.)
  - ✓ **Social capital** (i.e. Social interaction, Duration of stay in the locality etc.)
  - ✓ **Cohesion within community** (i.e. Community Based Organizations (CBO), Community groups etc.)

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Strength group
Gender	Women	
Age group	Children and Old	Young
Disability	Disable	
Education level	Illiterate	Educated

Figure: Women and children at Nepal earthquake (Source: Crossan, 2015)

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Strength group
Gender	Women	
Age group	Children and Old	Young
Disability	Disable	
Education level	Illiterate	Educated

Figure: Old and disable people in disaster (Source: Fackler, 2007; Arnold et al., 2018)

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Strength group
Gender	Women	
Age group	Children and Old	Young
Disability	Disable	
Education level	Illiterate	Literate or highly educated


Figure: Participation in disaster management (Source: Sariyuce et al. 2020; The New York Times, 2020)

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Strength group
Social status based on wealth	Lower status	Higher status
Political leadership		Influential persons
Race and ethnicity	Minor ethnic group and minority	
Family type	Nuclear family	Extended family


Figure: Disaster awareness and response (Source: SEEDS, 2020)

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Strength group
Social interaction	Lack of social interaction	Strong social interaction
Duration of stay	Shorter duration of stay	Longer duration of stay
Cohesion within community	Absence of community groups	Presence of community groups

Figure: Social interaction and cohesion (Source: Siddiqui, 2015; The New York Times, 2020)

Social Vulnerability Assessment: Determinants

- **Economic**
  - ✓ **Household income**
  - ✓ **Occupation**
  - ✓ **Asset ownership**

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Strength group
Household income	Low income	High income
Occupation	Unemployed	Employed
Asset ownership	Tenant	Owner

Figure: Disaster preparedness and reconstruction (Source: Nachtwey, 2016)

Social Vulnerability Assessment: Determinants

- **Awareness and preparedness**
  - ✓ Acknowledgment about awareness of earthquake
  - ✓ Source of knowledge
  - ✓ Knowledge about earthquake
  - ✓ Knowledge about response at the event of an earthquake
  - ✓ Actual response of people remembering past earthquake experience
  - ✓ Perception about earthquake vulnerability of area and building they are residing in.
  - ✓ Perception about reasons of earthquake vulnerability of the area and building
  - ✓ Knowledge about the existing disaster management committee at local level.
  - ✓ Willingness to participate in disaster management
  - ✓ Existing household preparedness level

Social Vulnerability Assessment: Interpretation of determinants

Based on	Concerned group	Explanation
Awareness	Lower awareness	• Lead to wrong perception • Lack of willingness to understand the risk and participate in training • Discourage participation in disaster management and preparedness
Knowledge and source of knowledge	Inappropriate knowledge from unauthentic source	
Perception about vulnerability	Inappropriate perception	
Household preparedness	Lack of preparedness	• Inappropriate response • Lack of capacity for recovery
Willingness to participate in disaster management	Lack of willingness	

Structural Vulnerability

- Structural Vulnerability refers to any weakness of the structure (like buildings) that can be exploited by any aggressor (like earthquake) or, in a non-terrorist threat environment, make that structure susceptible to hazard damage.
- An identified vulnerability may indicate that an asset (like structure):
  - ✓ is vulnerable to more than one threat or hazard.
  - ✓ and the mitigation measures may reduce vulnerability to one or more threats or hazards.
- To assess structural vulnerability followings are done
  - ✓ Visual Assessment (Rapid Visual Screening)
  - ✓ Detailed Engineering Assessment

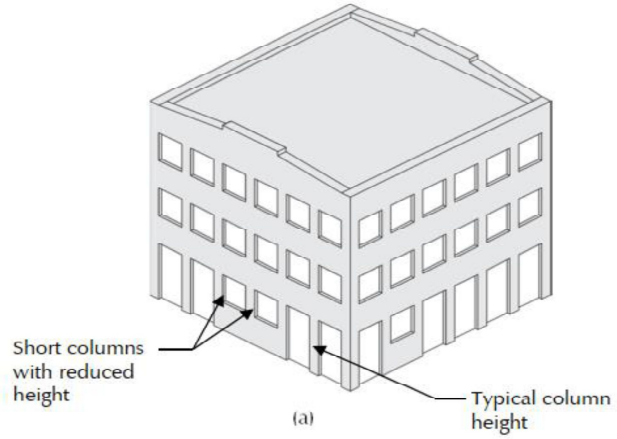
Features of Structural Vulnerability

- Vertical Irregularity
  - ✓ Short column
  - ✓ Soft storey
  - ✓ Split Level
  - ✓ Sloping Site
- Plan Irregularity
  - ✓ Torsional irregularity
  - ✓ Reentrant corner
- Insufficient gap between buildings
- Poor detailing
- Poor concrete quality

Features of Structural Vulnerability

Vertical Irregularity

- **Short column**



(a) (b)

Figure 3: Short column due to a) reduced height, b) partially infill walls

Features of Structural Vulnerability

Vertical Irregularity

- **Soft storey**

Lateral stiffness is less than 70% of that in the storey above or less than 80% of the average lateral stiffness of the three storeys above.

Figure 5: Soft Storey

Figure 6b: Soft Storey due to parking area

Figure 6a: Soft Storey

Soft- Story: Gujarat EQ, Jan. 26, 2001

Features of Structural Vulnerability

Vertical Irregularity

- **Split level**

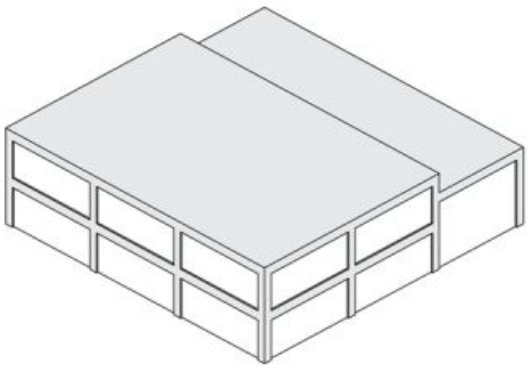


Figure 4: Split level

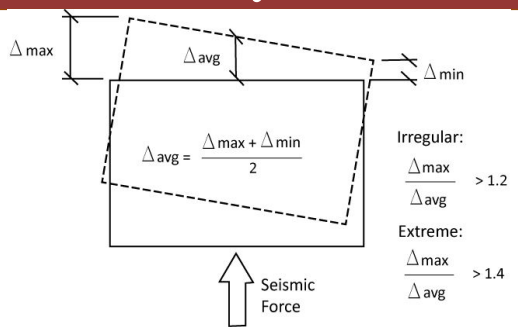
This condition occurs where floor or roof levels in one part of the building do not align with floor or roof levels in other parts of the buildings.

Features of Structural Vulnerability

Plan Irregularity

- **Torsional irregularity**

Maximum storey drift (Δ_max) at one end of the structure is more than 1.2 times the average (Δ_avg = (Δ_max+Δ_min)/2) of the storey drifts at the two ends of the structure.



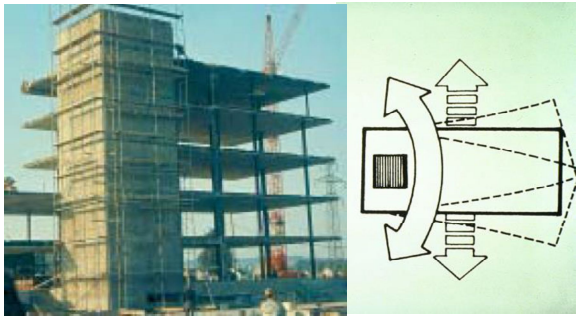
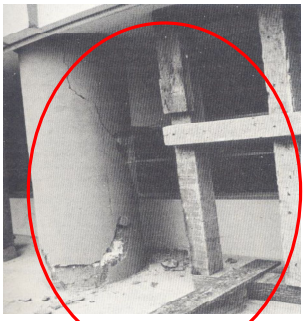


Figure 7: Torsional Irregularity



Lima EQ, Peru, Oct. 17, 1966

Features of Structural Vulnerability

Plan Irregularity

- **Reentrant corner**

Both projections of the structure beyond a re-entrant comer are greater than 15 percent of its plan dimension in the given direction.

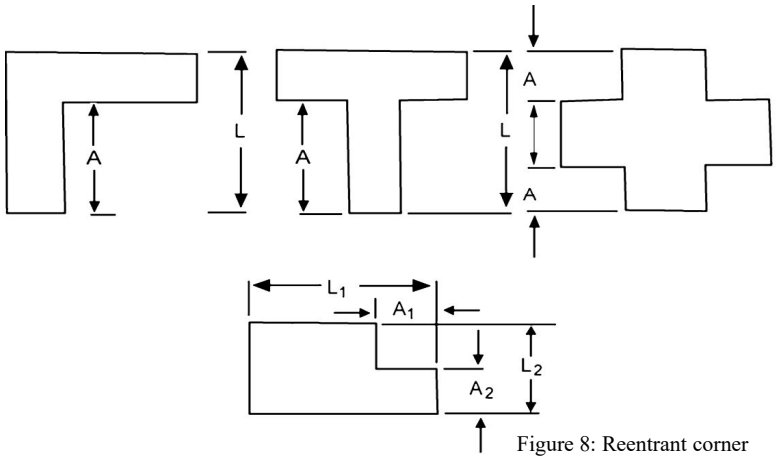
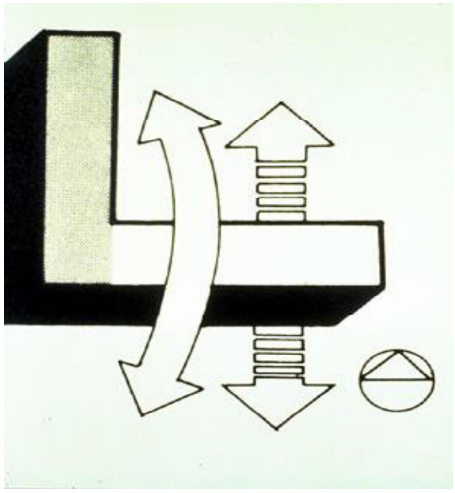
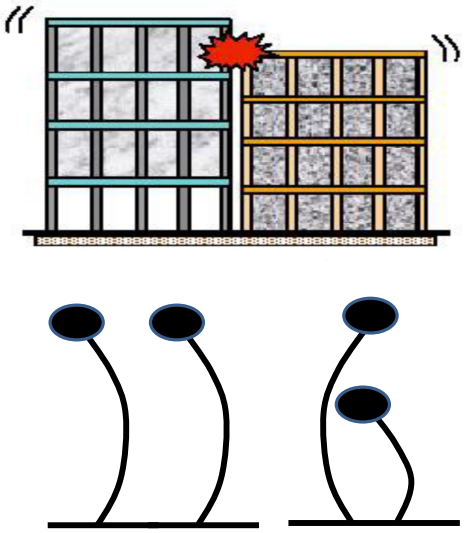


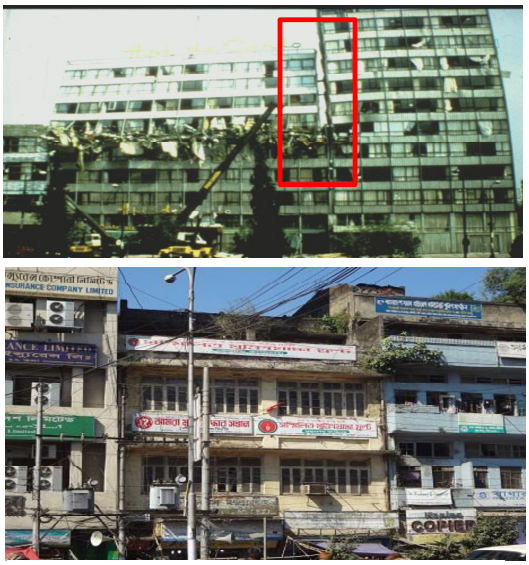
Figure 8: Reentrant corner



Features of Structural Vulnerability

Insufficient gap between buildings





Mexico City Earthquake, Sept. 19, 1985

Figure 9: Insufficient gap

Features of Structural Vulnerability

Poor detailing

Good Detail

Poor Detail

Figure 10: Insufficient gap

(At Gujarat Earthquake, Jan. 26, 2001)

Features of Structural Vulnerability

Poor concrete quality

Figure 11: Poor concrete quality

a. (Santa Barbara EQ, 1925)

b. (El Asnam EQ, Algeria, 1980)

Features of Non-Structural Vulnerability

- Part of buildings which are non-structural, such as ***Falling Hazards from taller adjacent buildings*** may also cause serious injuries during a disaster

Figure 12: Unsupported Water Tank

Figure 13: Unsupported Parapet

Figure 14: Cornices

Figure 15: Heavy Cladding

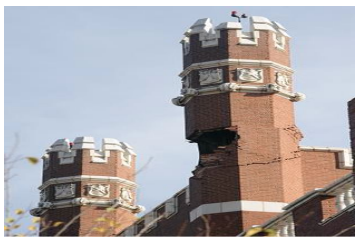


Figure 16: Masonry Tower

Figure 17: Chimney

Detailed Engineering Assessment (DEA)

- A Detailed Engineering Assessment (DEA) is a detailed structural engineering investigation and reporting of a building structure
- Necessary when there is insufficient information and documentation on the building structure to determine the safety of the structure/found unsafe in visual survey.
- Intrusive or destructive assessment is expected to be used during this detailed assessment.
- DEA includes:
  - Super structure Assessment
  - Sub-structure Assessment

Detailed Engineering Assessment (DEA)

Superstructure Assessment

- This includes inspection and testing of structural members (above ground) and their materials
- The following are included in this process
  - ✓ Preparation of as built drawing
  - ✓ Material strength determination
  - ✓ Checking reinforcements
  - ✓ Inspection of distress, excessive deformation, spalling, corrosion etc.

Detailed Engineering Assessment (DEA)

Substructure Assessment

Purpose of substructure assessment:

- Identify the nature of deposit (type and thickness of soil layers)
- Assess the suitability of sub-soil for the anticipated loads (from building)
- Determine the location of ground water table and its variation
- Assess potential foundation problems (e.g. expansive soil, collapsible soil, liquefiable soil, ground settlement/heaving etc.)
- Check if appropriate type of foundation and depths have been ensured
- Collect soil samples to perform laboratory tests for soil characterization and determination of various appropriate design parameters.

Detailed Engineering Assessment (DEA)

Substructure Assessment

Steps in soil investigation:

- Collection of Background Information
- Field Reconnaissance
- Bore-hole Drilling
- Collection of Soil Samples
- Field Tests (SPT, CPT etc.)
- Laboratory Test on Soil Samples
- Preparation of Geotechnical Report

Critical Infrastructure and Lifeline Vulnerability

- It includes the assets, systems, facilities, networks, and other elements that society relies upon to maintain national security, economic vitality, and public health and safety.
- There are four designated lifeline functions- transportation, water, energy, and communications, which means that their reliable operations are so critical that a disruption or loss of one of these functions will directly affect the security and resilience of critical infrastructure within and across numerous sectors.
- For example, energy stakeholders provide essential power and fuels to stakeholders in the communication, transportation, and water sectors, and, in return, the energy sector relies on them for fuel delivery (transportation), electricity generation (water for production and cooling), as well as control and operation of infrastructure (communication).
- These connections and interdependencies between infrastructure elements and sectors mean that the loss of one or more lifeline function(s) typically has an immediate impact on the operation or mission in multiple sectors (CISA, 2019).

Critical Infrastructure and Lifeline Vulnerability

- Life lines infrastructure and critical facilities include basic urban services such as
  - ✓ Water supply
  - ✓ Sanitary drainage
  - ✓ Storm drainage
  - ✓ Electricity supply
  - ✓ Gas and oil supply
  - ✓ Telecommunication services
  - ✓ Road, highway and bridges
  - ✓ Railways
  - ✓ Airports

Critical Infrastructure and Lifeline Vulnerability

Components of critical infrastructure vulnerability assessment

- Functional component
  - ✓ Specify lifeline features
  - ✓ Dependency on other systems and lifelines.
  - ✓ Degree of functional dependency of emergency systems and other urban systems on lifelines
- Organizational component
  - ✓ Organization within each lifeline company, number of companies for each lifeline
  - ✓ Intra agencies cooperation
  - ✓ Cooperation among different lifelines companies
- Physical component
  - ✓ Vulnerability of each lifeline
  - ✓ Physical vulnerability of lifeline essential for the function of other lifelines
  - ✓ Physical vulnerability of systems which lifelines are physically connected (Menoni et al, 2002)

Critical Infrastructure and Lifeline Vulnerability

Factors needs to be considered to assess the vulnerability

- An understanding of the diversity of hazards and threats they could face
- Extent of disruption due to a hazard
- Role and capability of different lifeline agencies and understanding their coordination network
- A consideration of the complexity of cross-sector connections including different agencies (other than lifelines)
- Secondary and indirect consequences on the economy and on society in general due to services interruption (Menoni et al, 2002; Lewis & Petit, n.d)
- Availability of provision of centrally controlled unit for emergency shut-off of lifelines which may cause secondary hazards

Thank You

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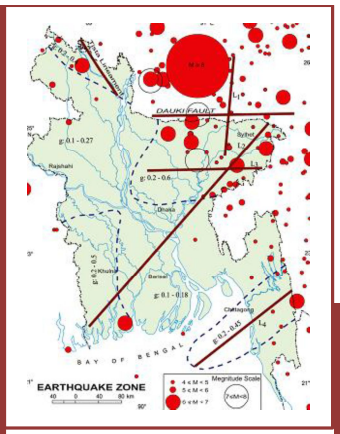

Lesson 4
Earthquake Risk Reduction Measures

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About the Lesson

- This lesson aims to provide better understanding about earthquake risk reduction measures.
- At the end of the lesson we would learn
  - ✓ Risk sensitive land use planning approach and key considerations behind that.
  - ✓ Resilient and sustainable construction criteria.
  - ✓ Implementation of legal measures to mitigate the earthquake risk.

Disaster Risk Reduction Strategies

- Environmental management
- Land use planning
- Protection of critical facilities
- Networking and partnerships
- Financial and economic tools
- Early warning systems (Twigg, 2004 & ISDR, 2002)

Disaster Risk Reduction Strategies

- **<u>Environmental management</u>:** Environmental management tools for Disaster Risk Reduction
  - ✓ Environmental legislation
  - ✓ Environmental policies and planning
  - ✓ Institutional arrangements
  - ✓ Environmental impact assessments
  - ✓ Reporting on the state of the environment
  - ✓ Ecological/environmental economics
  - ✓ Environmental codes and standards (Twigg, 2004 & ISDR, 2002)

Disaster Risk Reduction Strategies

- **Land use planning:** Application of informed and consistent planning practices are crucial to minimize the potential loss of physical assets or environmental capital, a greater principle lies in **treating the landscape itself as a valued resource to manage risk.**
- **Protection of critical facilities**: All societies need to be highly selective in the identification and protection of their key resources and service facilities so they can remain functional at the time of crisis or following a major disaster.

CRITICAL INFRASTRUCTURE AND KEY ASSETS

Infrastructure
Agriculture and Food
Water
Public Health
Emergency Services
Defense Industrial Base
Telecommunications
Energy
Transportation
Banking and Finance
Chemicals and Hazardous Materials
Postal and Shipping

Assets
National Monuments and Icons
Nuclear Power Plants
Dams
Government Facilities
Commercial Key Assets

Disaster Risk Reduction Strategies

- **Networking and partnerships**: Comprehensive disaster risk reduction covers a wide range of disciplines, sectors and institutions, calling for diverse and expanded forms of partnerships. The **achievements from networking and resulting partnerships can be far more powerful than the total of individual or specialist contributions**, alone (Twigg, 2004 & ISDR, 2002).

Disaster Risk Reduction Strategies

- **Financial and economic tools:**
  - ✓ Economic mechanisms: Livelihood diversification and protecting assets
  - ✓ Financial mechanisms: Insurance and Micro-credit and other forms of micro-finance
- **Early warning systems**: Elements of the early warning chain are:
  - ✓ Forecast and prediction of impending extreme events
  - ✓ Warning processing and dissemination of information
  - ✓ Reaction (Twigg, 2004 & ISDR, 2002)

Risk Sensitive Land Use Planning (RSLUP)

Introduction

- Disaster Risk Reduction (DRR) deals with the concept and practice of reducing disaster risks by systematic efforts to analyze and manage the causal factors of disasters through:
  - ✓ Reducing exposure to hazards,
  - ✓ Lessening vulnerability of people and property,
  - ✓ Wise management of land and the environment
  - ✓ Improving preparedness for adverse events.

(Urban Development Directorate (UDD), 2016)

Risk Sensitive Land Use Planning (RSLUP)

Introduction

- Mainstreaming disaster management into the development planning process essentially means looking critically at each program, activity and project that is being planned, not only from the perspective of reducing the existing risks, but also from the perspective of minimizing its potential contribution to creation of new risks of disasters.
- According to Hyogo framework, land use planning is one of the ways of mainstreaming disaster management.
- Land use planning can be used as a powerful mitigation tool as it has the potential to mitigate and adapt to a number of hazards.
- Land use planning is compatible with disaster risk reduction because both are systematic, future oriented, decision oriented and proactive.

Risk Sensitive Land Use Planning (RSLUP)

Introduction

- Risk Sensitive Land Use Planning (RSLUP)
  - ✓ Integrates risk reduction
  - ✓ Allows communities to find the right mix of both development and risk reduction
  - ✓ Sometimes permits some risks for economic gain and vice versa.
- One of the most important principles of RSLUP is **to avoid development in the hazard prone areas** that are exposed to the risk of natural hazards (UDD, 2016) .

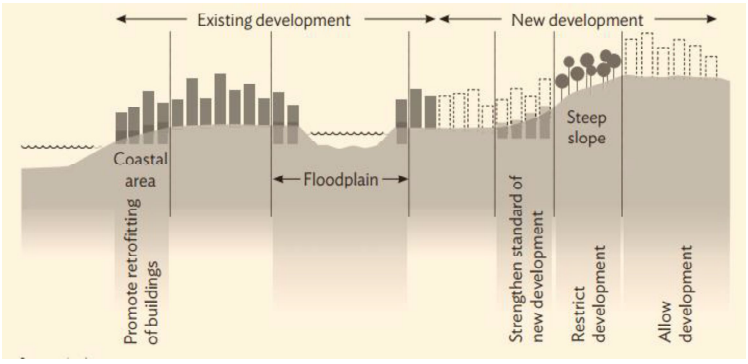

Figure 1: Risk-Sensitive Policies Proposed in a Land Use Plan (Source: ADB, 2016).

Risk Sensitive Land Use Planning (RSLUP)

Importance of RSLUP

- **Understand interaction between hazards and urban growth patterns**
  - ✓ Land use planning processes provide opportunities to understand how hazards interact with existing and future urban growth patterns, and they can propose a combination of measures (policy, investments, and capacity) that lead to risk-sensitive development.
  - ✓ For example, instruments for development control, such as incentive zoning can discourage development in areas with high liquefaction potential in the event of an earthquake.
- **Increase political and economic viability of disaster risk reduction solutions**:
  - ✓ By incorporating disaster risk considerations in urban land use management processes, the chances of implementing risk-sensitive urban growth may become more politically acceptable and economically viable (ADB, 2016).

Risk Sensitive Land Use Planning (RSLUP)

Importance of RSLUP

- ✓ For instance, acquiring a large parcel of land on an unstable slope and restricting development may not be politically and economically viable when landslide risk reduction objectives are considered alone, but it may become feasible when combined with objectives to address local development issues, such as the need for creating recreational and open spaces.
- **Build on existing processes, capacity, and resources, instead of new approaches:**
  - ✓ The broad principles guiding urban land use management—integrated, inclusive, and reflective— remain valid in the case of integrating disaster risk considerations.
  - ✓ Incorporating disaster risk considerations in land use management does not necessarily involve a new approach, but rather requires reflection to introduce incremental adjustments to established processes, capacity, and resources (ADB, 2016).

Risk Sensitive Land Use Planning (RSLUP)

Steps of Land Use Planning

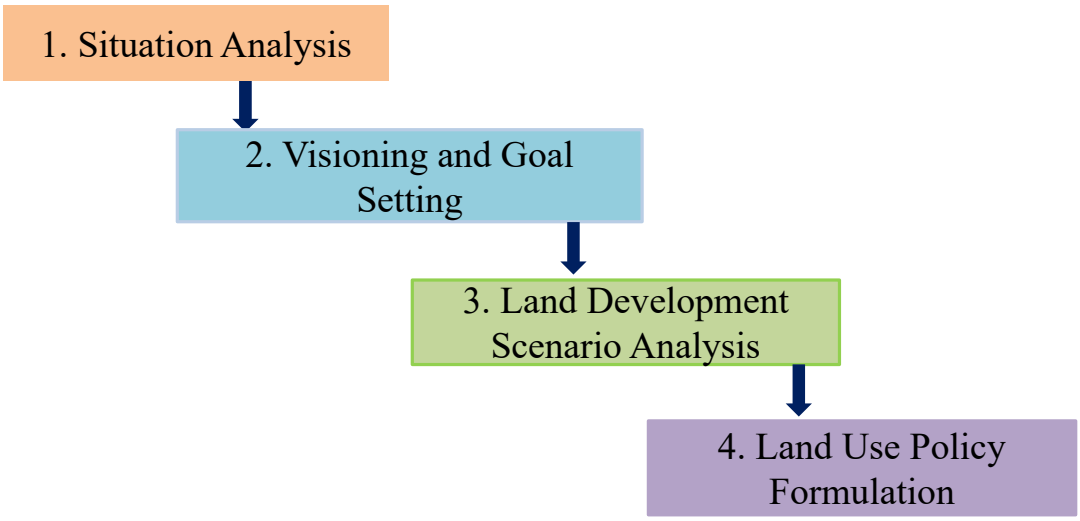

Figure 2: Steps of land use planning
(Source: ADB, 2016)

Risk Sensitive Land Use Planning (RSLUP)

Situation Analysis: Key DRR considerations

- Actions to integrate disaster risk considerations

Tasks	Key personnel or key document
Identify location of hazards and the population, area, and infrastructure that can be affected by a potential hazard event.	Hazard specialists, geologist, GIS experts
Identify location of environmental resources and sensitive areas, such as wetlands, coastal ecosystems, and natural water which help regulate and reduce hazard exposure	Environmental specialists and hydrologists
Identify factors contributing to the exposure and vulnerability of a community, such as the proximity of properties and critical infrastructure to fault lines, liquefaction zones; and construction and maintenance practices	Documents on the impacts of past large-scale disasters and recurrent hazards on different sectors as well as the broader macroeconomic impact of these events had on the city.

(Source: ADB, 2016).

Risk Sensitive Land Use Planning (RSLUP)

Situation Analysis: Key DRR considerations

- Outcome:
  - ✓ situation analysis report presents an objective statement on how hazards will impact projected demands for land, housing, infrastructure, transportation, employment, and waste management and what the key causal factors are (covering physical, social, economic conditions).
  - ✓ For example, in a city with high earthquake risk, a map showing the city's development constraints should include information on fault rupture zones, liquefaction areas, and landslide-prone slopes; and the accompanying description should explain how the hazard characteristics of the city will interact with future urban development (ADB, 2016).

Risk Sensitive Land Use Planning (RSLUP)

Situation Analysis: Key DRR considerations

- ✓ For example, in Mymensingh, earthquake sensitivity map was prepared where different level of sensitivity to Earthquake was demarcated (MSDP, 2011).

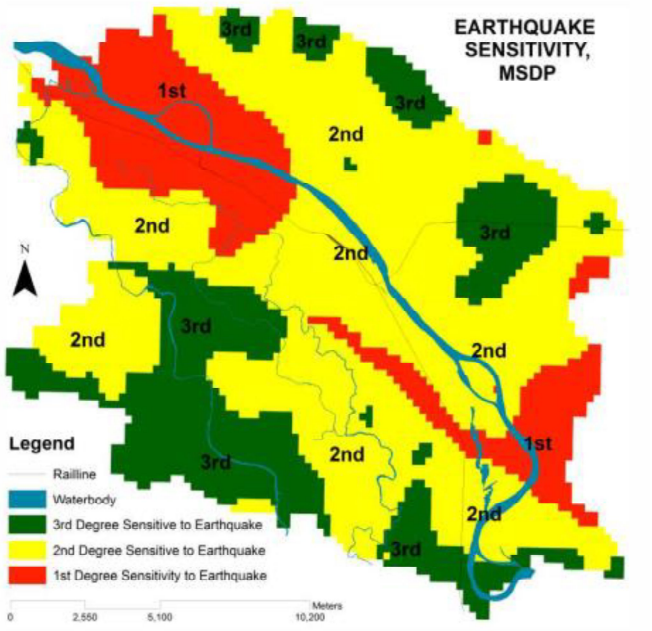

Figure 3: Earthquake sensitivity map, Mymensingh (Source: MSDP, 2011)

Risk Sensitive Land Use Planning (RSLUP)

Visioning and goal setting: Key DRR considerations

- Actions to integrate disaster risk considerations

Tasks	Key personnel or key document	Outcome
Raise awareness and initiate dialogue among stakeholders on the future performance of the city in the context of changing disaster risks.	Hazard specialists, climate change experts, GIS experts, geologist, Engineer, planners, architects etc.	Vision statement and goals informed by disaster risk considerations.
Formulate risk-informed goals and, where relevant, develop explicit land use goals aiming at reducing disaster risk.	Hazard specialists, climate change experts, planners	
Ensure that other **land use goals recognize the linkages with disaster risk** and do not unwittingly increase existing levels of risk.	Hazard specialists, climate change experts, planners	

(Source: ADB, 2016)

Risk Sensitive Land Use Planning (RSLUP)

Land Development Scenario Analysis: Key DRR considerations

- Actions to integrate disaster risk considerations

Tasks	Key personnel	Outcome
Examining the implications (spatial and temporal) of proposed land use scenarios (e.g., densifying existing built-up area or developing satellite towns, or a combination thereof) **on the level of disaster risk of the people, settlement, and infrastructure.** For example, densification may create pressure on existing vulnerable building stock and might require a retrofitting program. Likewise, expansion of the urban growth boundary into hazard-prone areas will encourage investments that will increase the city's overall disaster risk exposure	Hazard specialists, planners, GIS experts	Maps developed for various growth scenarios show development constraints posed by disaster risks
Highlight areas at risk and develop policy measures to ensure that all occupancy types can be safely undertaken.	Context specific	

(Source: ADB, 2016)

Risk Sensitive Land Use Planning (RSLUP)

Land Development Scenario Analysis: Key DRR considerations

- For example, in Mymensingh (MSDP), area suitable for high and low rise buildings, recommended building heights over the city etc. were illustrated (UDD, 2011).

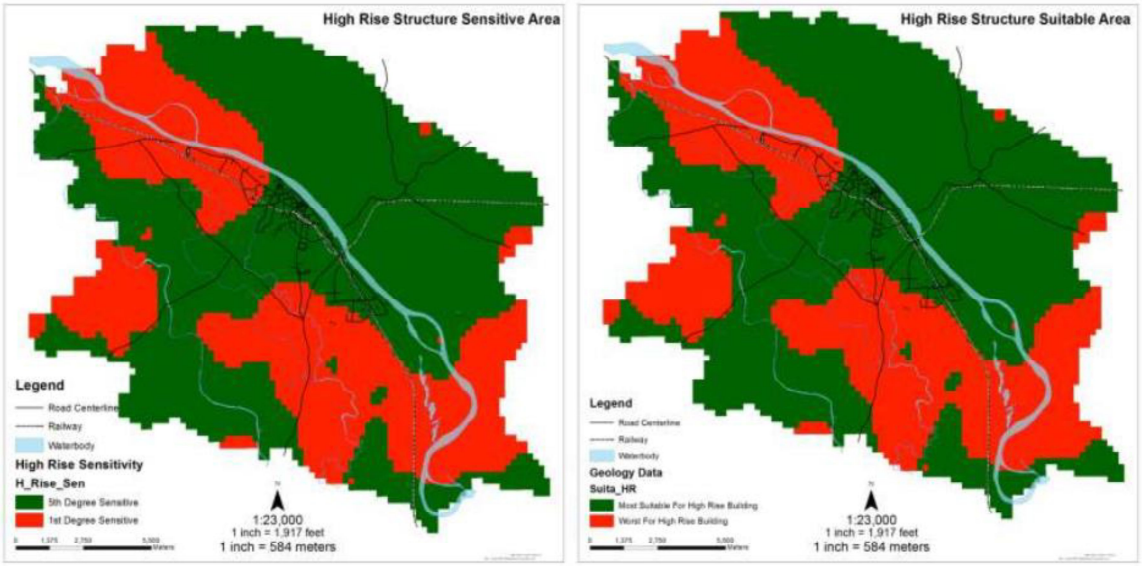

Figure 4: High rise building Earthquake sensitivity map and geological data, Mymensingh (Source: MSDP, 2011)

Risk Sensitive Land Use Planning (RSLUP)

Land Use Policy Formulation: Key DRR considerations

- Actions to integrate disaster risk considerations

Tasks	Key personnel	Outcome
Protecting hazard-prone and environmentally sensitive areas through regulations and incentives, and restricting development activities that can escalate risks (e.g., filling in wetlands that serve as natural flood management areas; logging upstream forested areas, which can lead to increased runoff and flooding in downstream urban areas)	Planners	Land use policy statements factor in disaster risk considerations.
Reducing disaster risk in development that has already expanded in hazard-prone areas, through regulations that restrict the type, density, and design of existing development, and policies that encourage investments in risk reduction measures. Promoting development in areas not prone to hazards, through regulations and incentive		

(Source: ADB, 2016)

Risk Sensitive Land Use Planning (RSLUP)

Land Use Policy Formulation: Key DRR Considerations

- For instance, in Dhaka, DMDP Structure Plan (1995-2015) stated some policies to integrate DDR in land use planning in different sectors
  - ✓ Areas of High Agricultural value;
  - ✓ Flood Control, Drainage and Irrigation Project Areas
  - ✓ Flood Plains, Rivers and Water Bodies.
  - ✓ Earthquake hazard, risk and vulnerability maps
- For example: Policies for Main Flood Flow Zone: Land Development for residential, commercial and industrial development including raising the level of land via land filling will strictly be prohibited.

Risk Sensitive Land Use Planning (RSLUP)

Land Use Policy Formulation: Key DRR considerations

- Different ways in which disaster risk reduction measures could be formulated include
  - ✓ Promoting risk-sensitive planning
  - ✓ Promoting disaster risk awareness
  - ✓ Investing in structural and nonstructural risk reduction measures
  - ✓ Strengthening the application of and compliance with building codes for new construction
  - ✓ Ensuring the design of critical infrastructure factors in disaster risk considerations
  - ✓ Reducing disaster risk in informal settlements
  - ✓ Promoting the retrofitting of high-occupancy buildings and critical facilities (Source: ADB, 2016).

Resilience

According to United Nations International Strategy for Disaster Reduction (UNISDR), "The ability of a system, community or society exposed to hazards to **resist, absorb, accommodate to and recover** from the effects of a hazard in a **timely and efficient manner,** including through the **preservation and restoration** of its essential basic structures and functions." (DRR, 2009)

Infrastructure Resilience

According to the National Infrastructure Advisory Council (NIAC, 2009), the 4 R's of Resilience are:

- **Robustness:** The ability to absorb or the capacity to withstand or resistance to a disaster.
- **Resourcefulness:** The preparedness for actions required during a disaster including adaptability.
- **Rapid Recovery:** The ability to recovery within short time after a disaster.
- **Redundancy:** Back up resources to support the originals.

Measure of Resilience

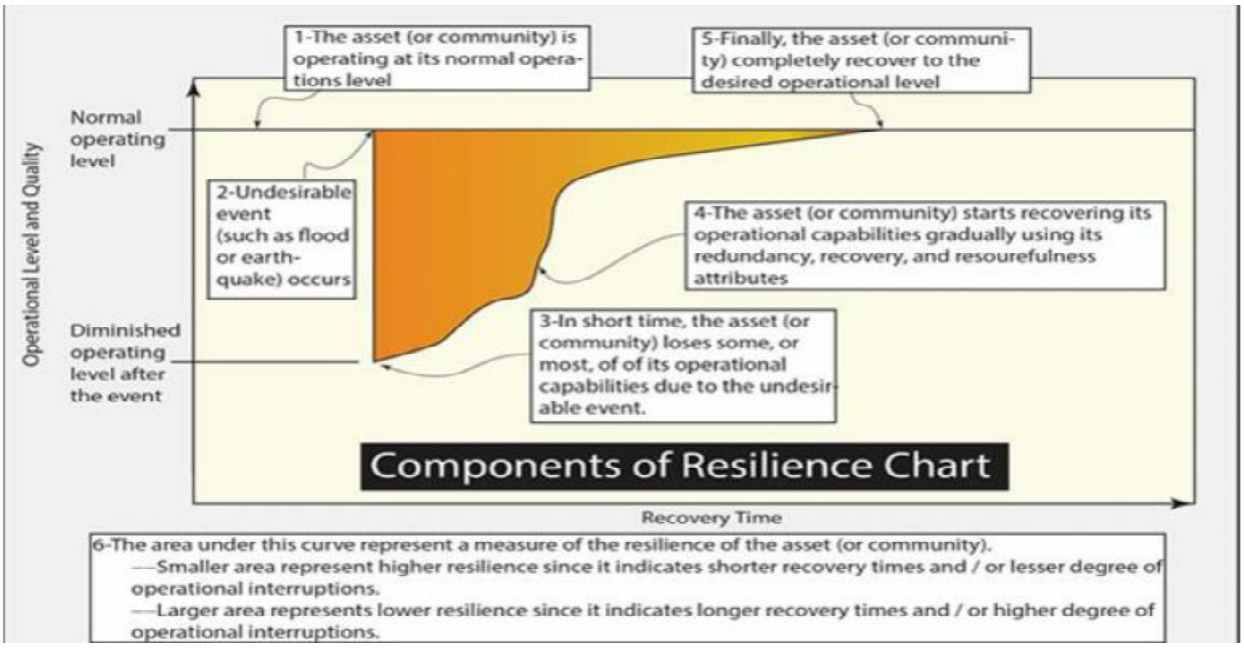

Figure 5: Components of resilience
(WBDG, 2018)

Sustainability

According to Our Common Future (UN, 1987), Sustainable Development is defined as development that **"meets the needs of the present without compromising the ability of future generations to meet their own needs."**

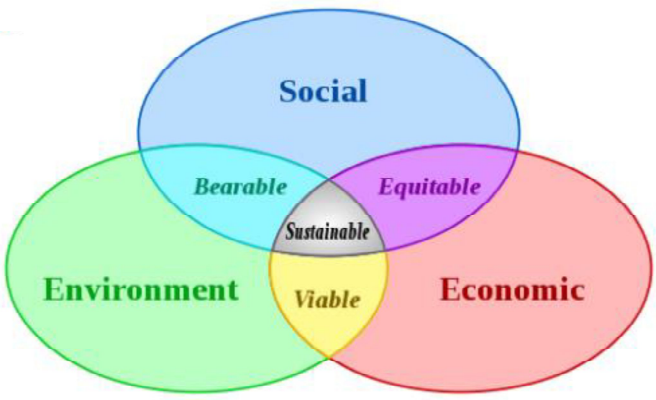

Figure 6: Sustainability
(Source: UN, 1987)

Sustainability Issues in Building Design and Construction

- Energy Efficiency
- Environment friendliness
- Construction Safety

Energy Efficient Building or Green Building

Building Concepts having a positive environmental impact and encourage sustainable construction practices, allowing efficiency and conservation of energy, water and building materials, and to promote resource efficiency.

- Site sustainability
- Building envelop
- Energy efficient building systems
- Internal water management
- Materials and Resources

Building Occupancy Class

Class	Building Type
A	Residential
B	Educational Facilities
C	Institution for Care
D	Healthcare Facilities
E	Business
F	Mercantile
G	Industrial Buildings

Class	Building Type
H	Storage Buildings
I	Assembly
J	Hazardous Building
K	Garage
L	Utility
M	Miscellaneous

Site Sustainability

- **Mandatory Unpaved Area**
  - Fifty (50) percent of mandatory open space shall be permeable on sites of all occupancy categories and will have green cover or be treated with perforated paving, organic mulch, charcoal etc.
- **Site Drainage**
  - Design shall indicate site drainage consideration along with flash loading and erosion prevention measures for sites above 1340 m^2 (*around 9 Katha*) in area.
- **Vegetation and Irrigation Plan**
  - For sites above three (3) acres, it is mandatory for a vegetation plan to be submitted along with the site plan and for sites ten (10) acres, an irrigation plan with construction details shall be submitted with the site plan.
- **Rain Water Harvesting System**
  - Buildings of total floor $> 4000m^2$ (*around 28 Katha*) shall have its own rain water harvesting system.

Source: BNBC, 2020

Building Envelope

- **Window Opening**
  - ✓ Mechanically ventilated and cooled buildings of all occupancies, other than hazardous, retail and storage, shall have the provision of using natural ventilation for cooling and fresh air, in frequently occupied areas , with a fraction > 4% of the floor area being specified as openable windows
- **Shading**
  - ✓ For naturally ventilated buildings of all occupancies, horizontal sunshades shall be provided over windows on South, East and West, the depth of which shall be calculated by multiplying the window height with a factor of 0.234.
  - ✓ 2 Vertical Shading devices shall be provided on the West
- **Roof Insulation and Green Roofing System**
  - ✓ Fifty (50) percent of horizontal exposed roof slabs of Buildings of Occupancy B, C, D and E, shall have green roofing system, to manage water run-off from roof tops, to control internal temperatures within the top floors and to reduce the carbon footprint of the building.

Source: BNBC, 2020

Energy Efficient Building Systems

- **Daylighting and Supplementary Lighting System**
  - Window area shall not be less than 14 percent or 1/7th of the total floor area of the building.
  - For buildings of occupancy A5(Hotel and lodging houses), B, C, E1(Offices) and E2(Research and testing laboratories), photoelecric sensors shall be connected to luminaries, to enable dimming or switching off lamps that do not require to be operated, due to the presence of adequate daylight.
- **Occupancy Sensors**
  - In order to limit the use of electricity in the unoccupied areas of buildings, occupancy sensors linked to lighting (except for emergency and security lighting) shall be installed in the public areas of buildings.
- **Ceiling/Wall Mounted Fans**
  - For naturally ventilated buildings of occupancy A, ceiling/wall mounted fans shall be provided in each regularly occupied space.
  - For buildings of occupancy B,C, D,E and I ceiling/wall mounted fans shall be provided in each room larger than 25 m^2, with a minimum of one fan every 25 m^2.

Source: BNBC, 2020

Energy Efficient Building Systems (contd)

- **Lift and Escalator Efficiencies**
  - ✓ Reduced speed control: The escalator shall change to a slower speed when no activity has been detected for a period of a maximum of three (3) minutes. Detection shall be by photocell activation at the top and bottom landing areas.
  - ✓ Use on demand: The escalator shall shut down when no activity has been detected for a period of a maximum of fifteen (15) minutes, designed with energy efficient soft start technology. The escalator shall start automatically when required; activation shall be by photocells installed in the top and bottom landing areas.
- **Renewable Energy Options**
  - ✓ Buildings of occupancy A shall use Solar or other renewable sources of energy to power 3% of the total electric load of the building.
  - ✓ Buildings of all occupancies other than A, shall use Solar or other renewable sources of energy to power 5% of the lighting and fan loads of the entire building.
- **Heating Ventilation and Air-conditioning (HVAC) System**
  - ✓ For conditioned buildings any Heating Ventilation and Air conditioning (HVAC) system planned for installation will meet energy efficiency standards specified in Part 8 of this Code.

Source: BNBC, 2020

Internal Water Management

- **Reuse of Grey Water**
  - ✓ Buildings of occupancy A5(Hotels and lodging houses), E1(Offices) and E2(Research and testing laboratories) and I shall reuse grey water for water efficiency and management.
  - ✓ Grey water from wash basin shall be reused in toilet flushing and/or irrigation after filtration to ensure a BOD (Biochemical Oxygen Demand) level <50. Such water shall not be considered potable.
- **Efficient Fittings in Toilets**
  - ✓ Water efficient fittings, including faucets, showerheads and flushes, that use less water for the same function as effectively as standard models, shall be used in buildings of all occupancies.
- **Service Hot Water and Pumping**
  - ✓ In order to reduce the energy used for water heating, buildings of occupancy A5(Hotels and lodging houses) and D1(Normal medical facilities) shall use solar hot water system to supply a minimum of thirty **(30)** percent of the total building hot water requirements. The solar hot water system can be flat plate solar collectors or vacuum tube solar system, this system must be designed and installed with the backup system or as a per heating for the main hot water system.

Source: BNBC, 2020

Materials and Resources

- Environmentally Preferable (EP) Materials
- Waste Management

Implementation of Measures

Establishment of Authority:

- The Government may, with the approval of the Ministry of Public Administration, Finance Division and other relevant Ministries and Divisions, by a notification in the official Gazette, establish the Bangladesh Building Regulatory Authority (BBRA).
- The Authority shall designate specific geographical jurisdiction as the Office of the Building Official.
- The Building Official shall exercise through a Building Construction Committee
- The Authority may, with the approval of the Government, constitute a Board of Appeal to hear and decide appeals.

Jurisdiction of Building Officials

Sl.	Area	Authority
1	Areas under the master plan of RAJUK	RAJUK
2	Areas under the master plan CDA	CDA
3	Areas under the master plan RDA	RDA
4	Areas under the master plan of KDA	KDA
5	Areas under any Development Authority	Relevant development authority
6	Areas under any City Corporation	Relevant city corporation
7	Areas under any Municipality	Relevant municipality
8	Areas not falling under any of the above	Office of The Executive Engineer PWD
9	Special areas, if any	To be declared by the government

Issuing of Different Types of Permit

Type of Permit	Validity	Time for Disposal
Land use certificate	24 months	15 days
Large and Specialized Project permit	24 months	45 days
Building permit	36 months	45 days
Occupancy certificate	Perpetual	15 days

Application of Permit:

- Filing application in writing on the prescribed form furnished by the Building official for that purpose
- Application for permit for any work under the provisions of BNBC Code shall be accompanied by necessary documents drawings, certificates, clearances and other relevant information as required by the Building Official for that particular city/town/municipality/jurisdiction area etc.

Land Use Clearance Certificate

The following information are required

- Location of land
- Land use within 250 meter radius of land
- Name and width of nearest main road
- Name and width of nearest road connecting to the plot
- Existence of following within 250 m of the plot- main road, market, station, airport, historical structure, river terminal, etc
- Average road benchmark elevation
- Land use around north, south, east, west sides of land
- Other important information

Special Project Permit

This should have following information

- Proposed development
- Total land area
- Maximum ground coverage
- Total floor area
- Total number of floors above plinth
- Total number of basements
- Total number of apartments for residential properties

Special Project Permit (contd)

- Number of existing structures within the area
- Approximate total electricity requirement
- Approximate total water consumption
- Proposed project development time in months with number of phases and duration of each phase
- Covered area of each floor of each type of use in a table
- Along with the above information, the following documents are also required

Special Project Permit (contd)

- Purchase ownership deed
- Relevant deed and permission if plot has been government allotted
- Receipt of payment of required fee
- FAR calculation
- Documents and drawings as per requirement
- Land use Clearance, if required

Building Permit

Building Category	Height of the Building	Floor Area
I	Up to 2 stories	Up to 250 m^2
II	Up to 5 stories	Up to 1000 m^2
III	Up to 10 stories	Up to 7500 m^2
IV	Any height	Any size

Following information are required

- Type of use of proposed building
- Details of proposed land with area
- Details of type of use with area
- Measurements of plot in all four sides with location of North, South, East, West in meters
- Total floor area of proposed project

Building Permit (Contd)

- Number of apartments per floor for residential properties
- Number of floors above plinth
- Basement covered with percentage of land area
- Floor area of different types of use
- Width of adjacent roads in front, rear, left and right side
- Details of existing structure if present
- Set back length in meter on front, rear, left and right side.

Purpose of Land Use Policy

Following are required

- To reduce the decreasing rate of reducing agricultural land
- To control the unplanned growth of residential area
- To ensure best use of alluvial land
- Prevention of future potential and govt. khash land
- To ensure land use is favorable to ecology
- Saving natural forest, blocking river erosion & reduce hill track damage
- To prevent soil pollution
- Ensure minimum land use through building multistoried govt. & private building for institution

Thank You

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- United Nations International Strategy for Disaster Reduction (ISDR) (2002). Living with risk: a global review of disaster reduction initiatives.
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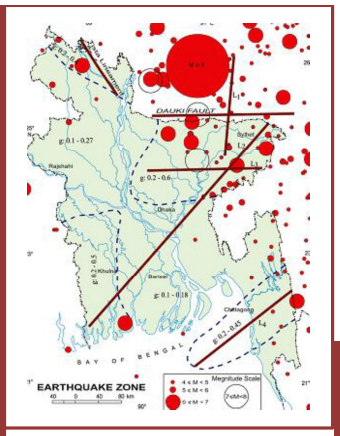
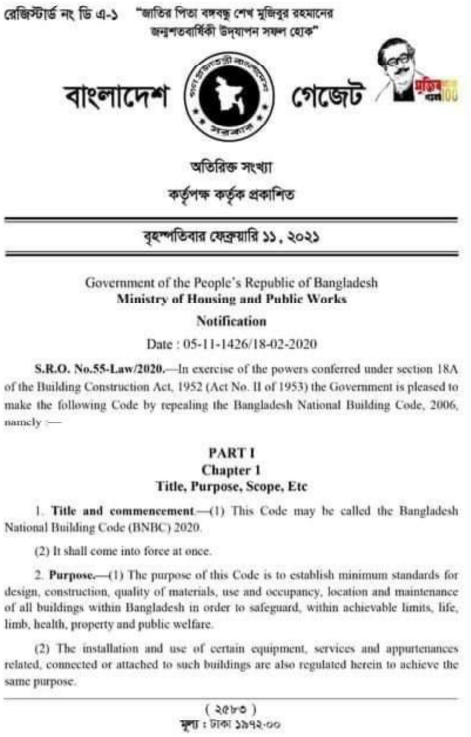
Thank You



Lesson Five

Building CODE Compliance

BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS),
Department of Urban and Regional Planning
Department of Civil Engineering
Bangladesh University of Engineering and Technology (BUET).
Dhaka-1000, Bangladesh.



রেজিস্টার্ড নং ডি এ-১ "জাতির পিতা বঙ্গবন্ধু শেখ মুজিবুর রহমানের জন্মশতবার্ষিকী উদ্‌যাপন সফল হোক"

বাংলাদেশ গেজেট

অতিরিক্ত সংখ্যা

কর্তৃপক্ষ কর্তৃক প্রকাশিত

বৃহস্পতিবার ফেব্রুয়ারি ১১, ২০২১

Government of the People's Republic of Bangladesh
Ministry of Housing and Public Works

Notification

Date : 05-11-1426/18-02-2020

S.R.O. No.55-Law/2020.—In exercise of the powers conferred under section 18A of the Building Construction Act, 1952 (Act No. II of 1953) the Government is pleased to make the following Code by repealing the Bangladesh National Building Code, 2006, namely :—

PART I
Chapter 1
Title, Purpose, Scope, Etc

1. **Title and commencement.**—(1) This Code may be called the Bangladesh National Building Code (BNBC) 2020.

(2) It shall come into force at once.

2. **Purpose.**—(1) The purpose of this Code is to establish minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of all buildings within Bangladesh in order to safeguard, within achievable limits, life, limb, health, property and public welfare.

(2) The installation and use of certain equipment, services and appurtenances related, connected or attached to such buildings are also regulated herein to achieve the same purpose.

(২৫৮৩)
মূল্য : টাকা ১৯৭২.০০

Building Construction Act

- Clause 18(A) of The Building Construction Act 1952:

  The Government may, by notification in the official Gazette, make provision to carry out the purposes of this Act and the provisions made under this section may collectively be called the Bangladesh National Building Code.

- The purpose of this Code is to establish minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of all buildings within Bangladesh in order to safeguard, within achievable limits, life, limb, health, property and public welfare.

History of BNBC

- The Building Construction Act was enacted in 1952
- The first draft Building Code was drafted in 1993 by HBRI
- The BC Act 1952 was amended in 2006 by giving power to make Bangladesh National Building Code
- BNBC was enacted through a Statutory Regulatory Order (SRO) in 2006.
- HBRI undertook BNBC updating project in 2009
- Final version of the updated code was submitted in 2015
- The updated code was gazette on 11February 2021

Parts of BNBC

- PART 1 SCOPE AND DEFINITION
- PART 2 ADMINISTRATION AND ENFORCEMENT
- PART 3 GENERAL BUILDING REQUIREMENTS, CONTROL AND REGULATION
- PART 4 FIRE PROTECTION
- PART 5 BUILDING MATERIALS
- PART 6 STRUCTURAL DESIGN
- PART 7 CONSTRUCTION PRACTICES AND SAFETY
- PART 8 BUILDING SERVICES
- PART 9 ADDITION, ALTERATION TO AND CHANGE OF USE OF EXISTING BUILDINGS
- PART 10 SIGNS AND OUT-DOOR DISPLAY

Building Code Administration

Part 2: Administration and Enforcement

- Chapter 1: Purpose and Applicability
- Chapter 2: Establishment of Authority, etc.
- Chapter 3: Permit and Inspections

Purpose of the Building Code

- The primary objectives are to make sure that new construction and renovated buildings provide a minimum level of safety, health, and welfare to the occupants and the public.
- These are addressed by imposing minimum requirements that the designer has to satisfy or even exceed these minimums.
- More Specifically, a building code aims at achieving the following purposes:
    - Life safety
    - Structural safety
    - Fire safety
    - Health and welfare
- Building code is not meant for general public. It is for professionals.

Definition of Building

- Any permanent or semi-permanent structure which is constructed or erected for human habitation or for any other purpose and includes but not limited to the foundation, plinth, walls, floors, roofs, stairs, chimneys, fixed platform, verandah, balcony, cornice, projections, extensions, annexes etc.
- Will also include the sanitary, plumbing, electrical, HVAC, appurtenances and all other building service installations which are constructed or erected as an integral part of a building.

Establishment of Authority

- The Government may, with the approval of the Ministry of Public Administration, Finance Division and other relevant Ministries and Divisions, by a notification in the official Gazette, establish the Bangladesh Building Regulatory Authority (BBRA).
- The Authority shall designate specific geographical jurisdiction as the Office of the Building Official.
- The Building Official shall exercise through a Building Construction Committee
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Jurisdiction of Building Officials

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6	Areas under any City Corporation	Relevant city corporation
7	Areas under any Municipality	Relevant municipality
8	Areas not falling under any of the above	Office of The Executive Engineer PWD
9	Special areas, if any	To be declared by the government

Types of Permits and Building Categories

Type of Permit	Validity	Time for Disposal
Land use certificate	24 months	15 days
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Occupancy certificate	Perpetual	15 days

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IV	Any height	Any size

Eligible Registered Professionals

Types of Work	Registered Professional	Minimum Experience for Building Category			
		I	II	III	IV
Survey	Diploma Engineer	NA	3	3	3
Soil Test	Civil Engineer	NA	2	2	5
Arch Design	Architect	NA	NR	2	8
Struc Design	Civil Engineer	NA	2	4	8
Plumbing	Plumbing Engineer	NA	NR	4	8
Mechanical	Mechanical Engineer	NA	2	4	8
Electrical	Electrical Engineer	NA	2	4	8
Supervision	Architect/Engineer Dip Arch/Dip Engr	NA NA	2 2	4 4	8 NE
Demolition	Civil Engineer	NA	NR	2	8
Completion	Architect and Engineer	NA	2	4	8

Part 3: Architectural Provisions

- Requirements of plots (drainage, formation level etc.)
- Plot sizes
- Means of access
- Open spaces within a plot (setbacks, ground coverage etc.)
- General height and area limitations (FAR etc.)
- Off-street parking spaces
- Street encroachment
- Community open space and amenities
- Minimum standard of a dwelling
- Requirements of parts of buildings
- Landscaping
- Damp-proofing and waterproofing

Addressed Architectural Issues

- Existing buildings
- Buildings and areas of architectural value
- Ventilation, lighting and sanitation
- Air-conditioning and heating
- Lifts and escalators
- Sound insulation
- Thermal insulation
- Lightning protection of buildings
- Rat proofing and termite proofing
- Requirements of buildings in flood prone and coastal regions
- Requirements for buildings in other disaster prone areas
- Special provisions for storage of dangerous goods

Occupancy Classification

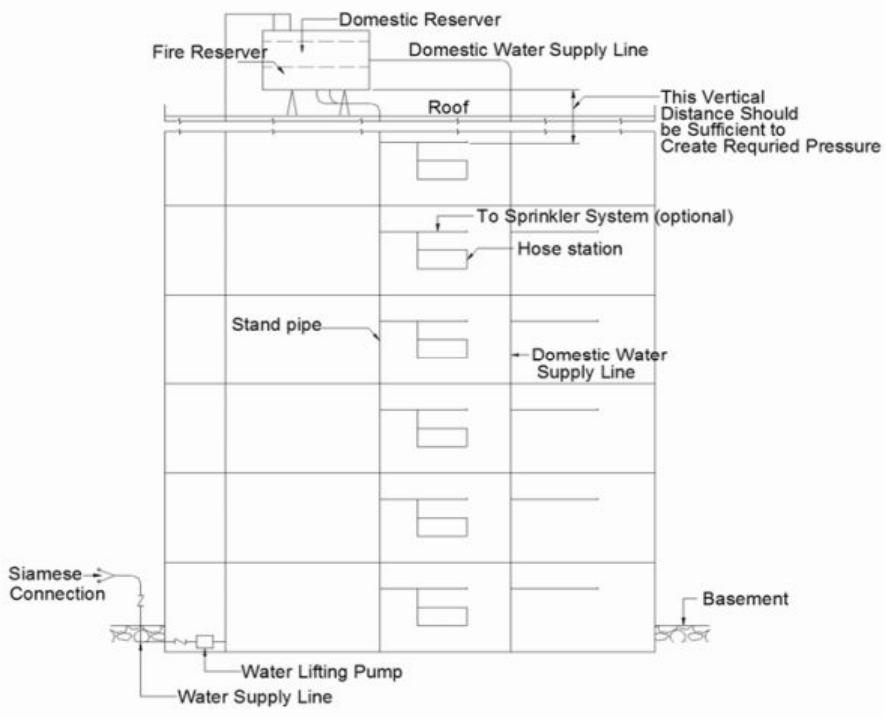
- A: Residential
- B: Educational Facilities
- C: Institution for Care
- D: Health Care Facilities
- E: Business
- F: Mercantile
- G: Industrial Buildings
- H: Storage Buildings
- I: Assembly
- J: Hazardous Building
- K: Garage
- L: Utility
- Miscellaneous

Energy Efficiency and Sustainability

- Scope: Building concepts having a positive environmental impact and encourage sustainable construction practices, allowing efficiency and conservation of energy, water and building materials, and to promote resource efficiency
- Site sustainability
- Building envelope
- Energy efficient building systems
- Internal water management

Part 4: Fire Protection

- It has been addressed in Part-4 of BNBC
- Chapter 1: General Provisions
- Chapter 2: Precautionary Requirements
- Chapter 3: Means of Egress
- Chapter 4: Equipment and In-built Facilities Standards
- Chapter 5: Specific Requirements for Fire Detection and Extinguishing System



Typical diagram showing required static head of gravity roof tank with adequate domestic and fire reserve

General Requirements

- Fire drill: Fire drills based on fire order shall be arranged to train the occupants of a building in first-aid firefighting, relocation and orderly evacuation.
- Fire test: The fire resistance ratings of building assemblies and structural elements shall be determined in accordance with ASCE 29 or ASTM E 119.

Classification of the Construction Types

- Type- I A 4 hour protected
- Type- I B 3 hour protected
- Type- I C 2 hour protected
- Type- I D 1 hour protected
- Type- I E Unprotected

Means of Egress

- A means of egress is an evacuation system with the provisions of reentry for rescuers and fire fighters where a continuous and unobstructed way of exit travel shall be provided from any point within a building to a designated area of refuge for allowable delayed evacuation and ended up with the exit termination by reaching a street abutting building or plot or an safe area which is open to air and designated assemblies for evacuees.
- The way of exit travel within a building form any point thereof along a means of egress shall consist of three parts: (1) the exit access, (2) the exit, and (3) the exit discharge.

Part 5: Building Materials

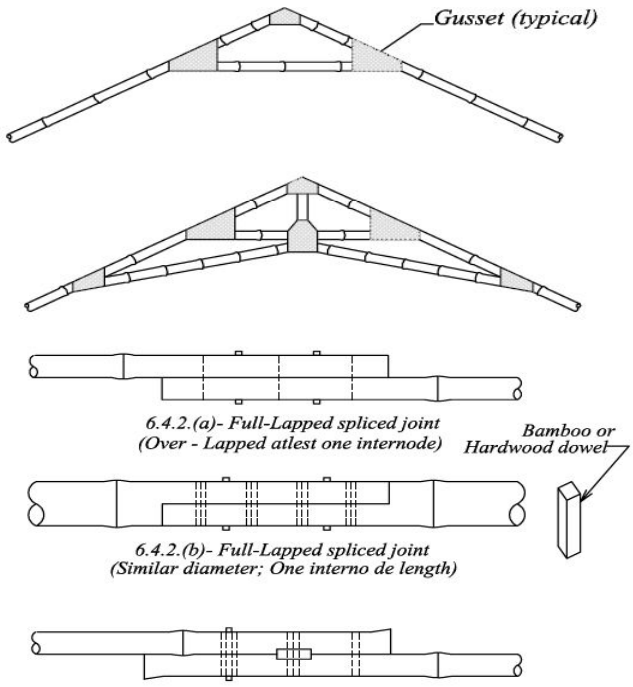
- Masonry
- Cement and concrete
- Pre-stressed concrete
- Building limes
- Gypsum based materials and plaster
- Flooring materials
- Steel
- Timber and wood products
- Doors, windows and ventilators
- Aluminum and aluminum alloys
- Builders hardware
- Roof coverings
- Paints and varnishes
- Sanitary appliances and water fitings
- Miscellaneous materials
- CGI sheet roofing and walling

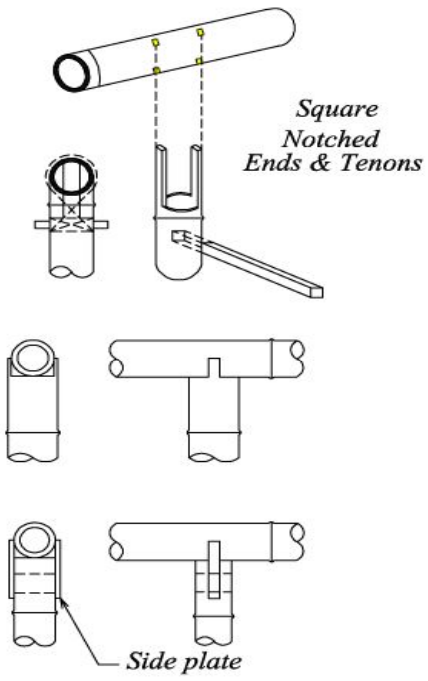
Part 6: Structural Provisions

Part 6: Structural Design

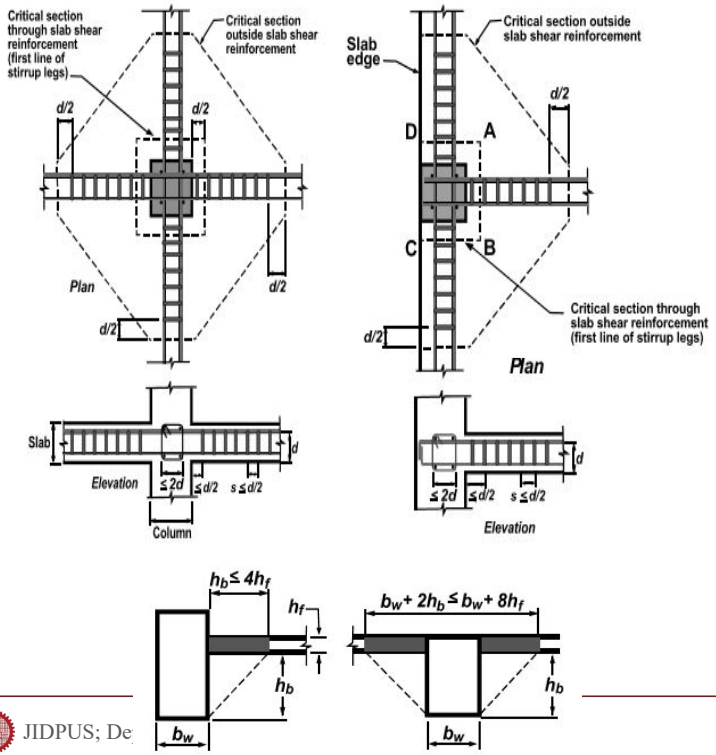
- Chapter 1: Definitions and General Requirements
- Chapter 2: Loads on Buildings and Structures
- Chapter 3: Soils and Foundations
- Chapter 4: Bamboo
- Chapter 5: Concrete Material
- Chapter 6: Strength Design of Reinforced Concrete Structures
- Chapter 7: Masonry Structures
- Chapter 8: Detailing of Reinforced Concrete Structures
- Chapter 9: Prestressed Concrete Structures
- Chapter 10: Steel Structures
- Chapter 11: Timber
- Chapter 12: Ferrocement Structures
- Chapter 13: Steel-concrete Composite Structural Members

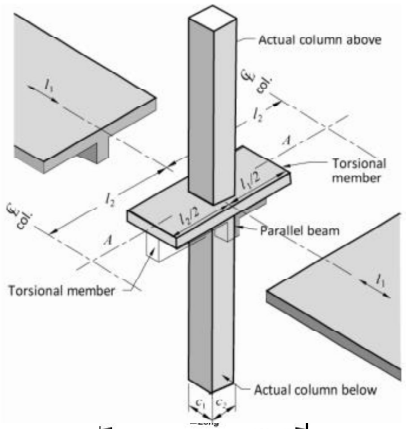
Bamboo

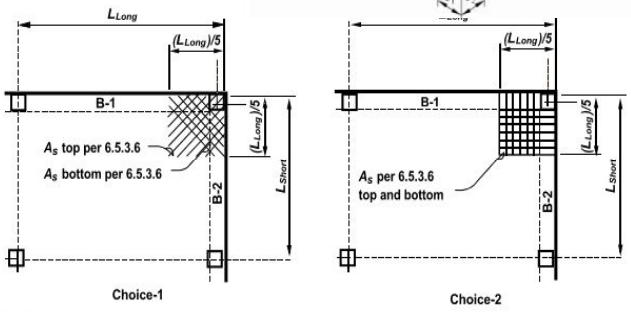




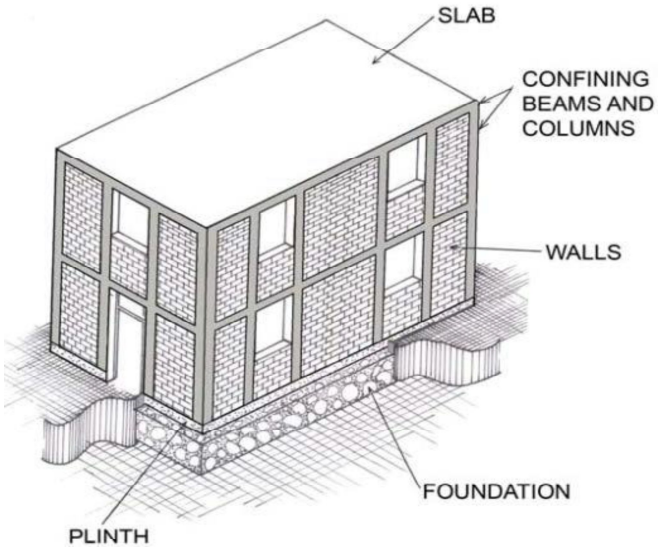
Reinforced Concrete Structures

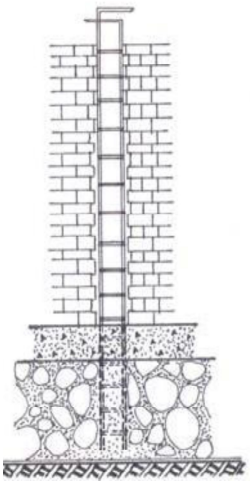


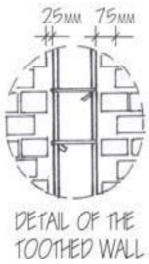


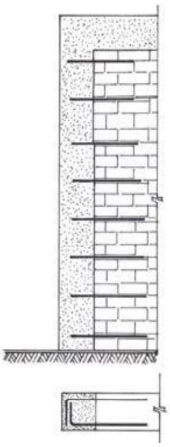


Confined Masonry

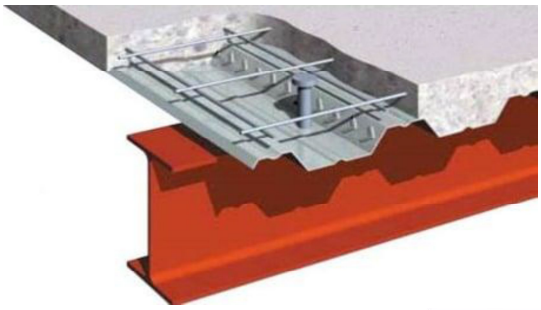


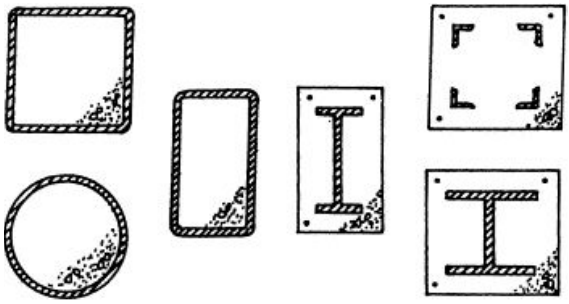


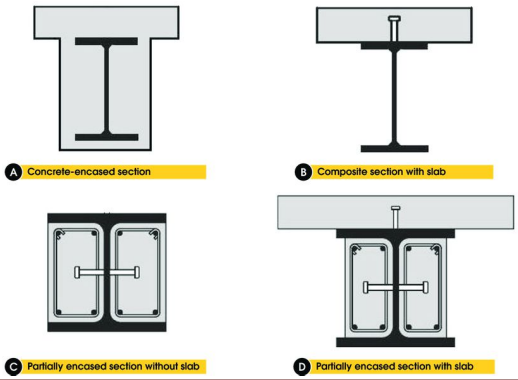




Steel Concrete Composite Structures







Part 7: Construction Practices and Safety

- Chapter 1: Constructional Responsibilities and Practices
- Chapter 2: Storage, Stacking and Handling Practices
- Chapter 3: Safety During Construction
- Chapter 4: Demolition Work
- Chapter 5: Maintenance Management, Repairs, Retrofitting and Strengthening of Buildings

Part 8: MEP Provisions

Part 8: Building Services

- Chapter 1: Electrical and Electronic Engineering Services for Buildings
- Chapter 2: Air-conditioning, Heating and Ventilation
- Chapter 3: Building Acoustics
- Chapter 4: Lifts, Escalators and Moving Walks
- Chapter 5: Water Supply
- Chapter 6: Sanitary Drainage
- Chapter 7: Rainwater Management
- Chapter 8: Fuel Gas Supply

Electrical Services for Buildings

- Lighting
- Load estimation
- Fittings, fixtures and accessories
- Wiring
- Substation and transformer
- Distribution system
- Switch and switchboards
- Overcurrent and short-circuit protection
- Fire detection, alarm and emergency lighting
- Earthing
- Lightning protection
- Telecommunication
- CCTV and access control system

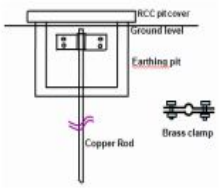


Figure 8.1.2 Copper Rod Earthing

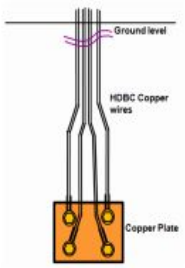
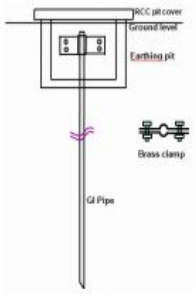
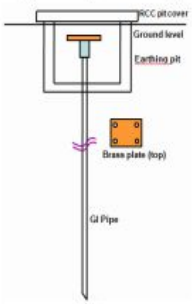


Figure 8.1.3 Copper Plate Earthing



(a)



(b)

HVAC

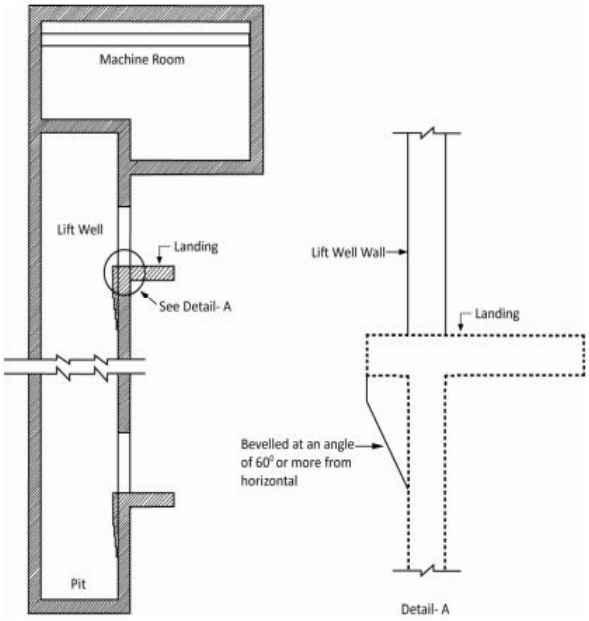
- Planning
- Air-conditioning system design
- Air distribution system
- Air-conditioning equipment
- Refrigerating equipment
- Ventilation systems
- Energy conservation
- Inspection, testing and commissioning
- Operation and maintenance

Building Acoustics

- Classification
- Planning
- Design
- Speech privacy
- Sound amplification system

Lifts and Escalators

- Safety considerations
- Design considerations
- Escalators
- Moving walks
- Energy conservation
- Inspection and certification
- Operation and maintenance



Water Supply

- Permit
- Licensing of plumbers
- Water supply requirements
- Estimation of demand load
- Water sources and quality
- Inspection and certification
- Water supply system
- Storage of water
- Design of distribution system
- Water distribution in tall buildings
- Hot water supply installation
- Pipe work
- Cleaning and disinfection

Sanitary Drainage

- Planning
- Licensing of plumbers
- Drainage and sanitation requirements
- Materials and appliances
- Design considerations
- Refuse chute system
- Basement floor drainage system
- Healthcare drainage system
- Inspection, testing and completion certificate
- Guide to maintenance

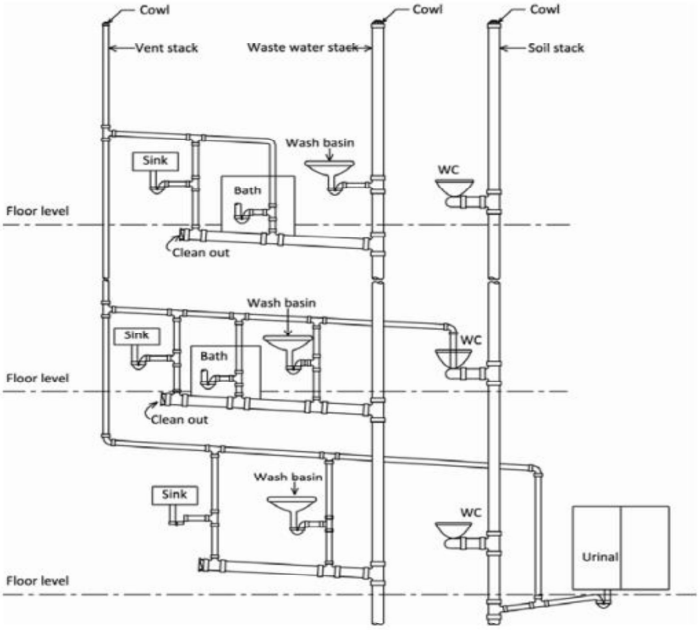


Diagram of two pipe system

Topics of Fuel and Gas Supply

- Gas piping installation
- Use of LPG
- Installation of appliances

Part 9: Alteration, Addition to and Change of Use of Existing Buildings

Part 8: Building Services

- Chapter 1: Applicability and Implementation
- Chapter 2: Evaluation and Compliance
- Chapter 3: Conservation

Applicability

- No change in use shall be made without permission from the permitting authority.
- No addition shall be made without permission from the permitting authority.
- An existing building shall not be altered in such a manner that results in the building being less safe or sanitary.
- Any construction which does not have approval of the appropriate authority must be removed before any new addition, alteration or change of use.

Part 10: Signs and Outdoor Display

Part 8: Building Services

- Chapter 1: Scope and General
- Chapter 2: General Requirements
- Chapter 3: Specific Requirements of Various Types of Signs

Various Types of Signs

- Electric signs
- Ground signs
- Roof signs
- Projecting signs
- Fin signs
- Balcony signs
- Marquee signs

Responsibilities and Duties of Owner

- Employment of technical personnel
- Right of Entry
- Permits of other agencies
- Information on Progressive Work
- Safety Measures
- Notice of Completion
- Documents at Site
- Live load Posted

Responsibilities of Technical Personnel

- To qualify as Architect, Engineer, Construction Supervisor (Architect or Engineer or Diploma Architect or Diploma Engineer) of any building works, one shall have membership of the respective professional body in the country. In addition they shall have to qualify as registered professional through an examination (written/oral) to be conducted by their respective professional body as per requirement of this Code.
- Only technical professionals qualified (as told before) shall design, execute and supervise any building which is subjected to approval granted under this Code.
- Any lapses on the part of the technical personnel in delivering the requirements of the Code shall call for punitive actions against him/her in the proper forum.

Penalty

12. 23[(1) Whoever commits an offence by-

(c) designing or approving or implementing a building construction plan in contravention to any provision of the Bangladesh Building Code made under section 18A and the rules made under section 18

shall, on conviction before a Court of competent jurisdiction, be punishable with imprisonment for a term which may extend to seven years, or with fine not less than taka fifty thousand, or with both.

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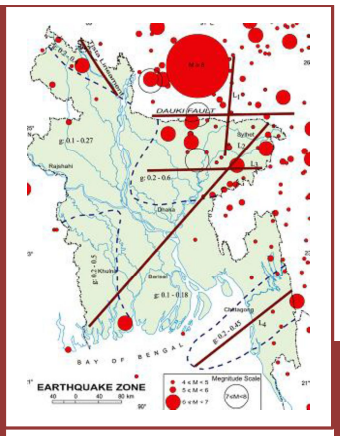

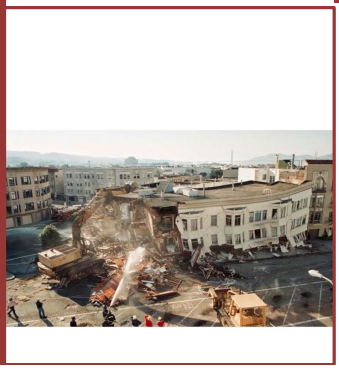

Lesson Six

Construction Safety

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Introduction

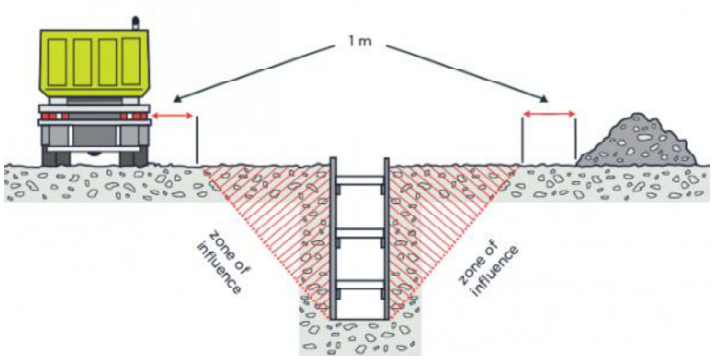
- Not only does safety on construction sites protect workers, but also keeps the public safe.
- Inadequate safety protocols can allow objects to fall on innocent bystanders, putting people not even connected to the project at high risk.
- Also, safety is a vital part of finishing a project on or under budget. Downtime is costly, as is finding replacement workers when someone cannot do their job after an accident.
- Worker's compensation claims and lawsuits can drive up your insurance costs. Focusing on safety helps keep your costs low.

Stages of Construction

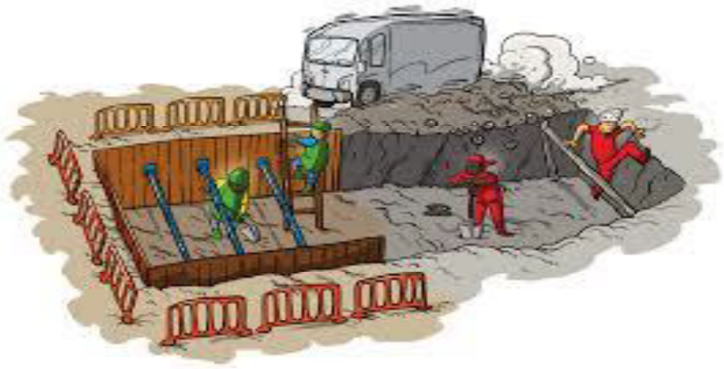
- Following are different construction stages
  - Excavation and Foundation Work
  - Pile Driving
  - Formwork and Scaffold
  - Concrete Work
  - Construction of Walls and Floors
  - Erection Operations
  - Electrification, Equipment installation and Operations
- Different safety measures need to be incorporated in different stages

Safety During Excavation and Foundation Work

- **Excavation machinery**: shall be kept away from the trenches by a distance at least equal to the depth of trench to a maximum of 6 meters
- **Excavated materials**: shall be kept away from the edges of the trench.
- **Ground water**: The water shall be drawn away from the excavation.
- **Ground conditions**: Adequate precautions against quick sand, loose fills etc. shall be taken to protect the workmen.
- **Overhang**: shall be supported by props.
- **Blast and vibration**: An analysis for the stability of slopes shall be carried out



Excavation machinery and the material should be kept away from the trench



Prop is being used during excavation

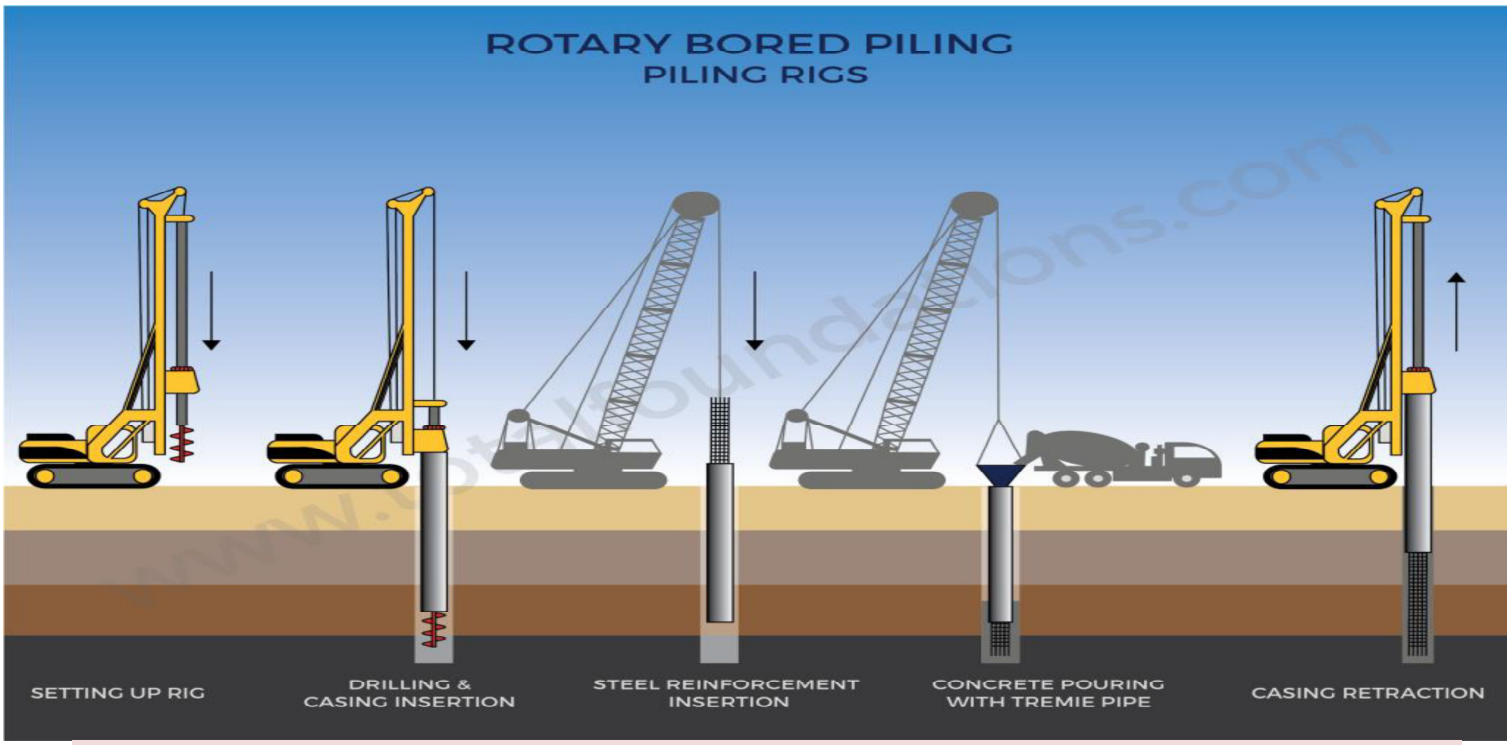
Safety During Excavation and Foundation Work

- **Health hazard**: Mechanical ventilation shall be provided if there is gas/fume.
- **Safety of materials**: Materials shall be inspected by the Engineer-in-charge.
- **Piling and deep foundations**: supervised by a competent Geotech Engineer
- **Adjoining properties and service lines**: Old structures to be monitored.

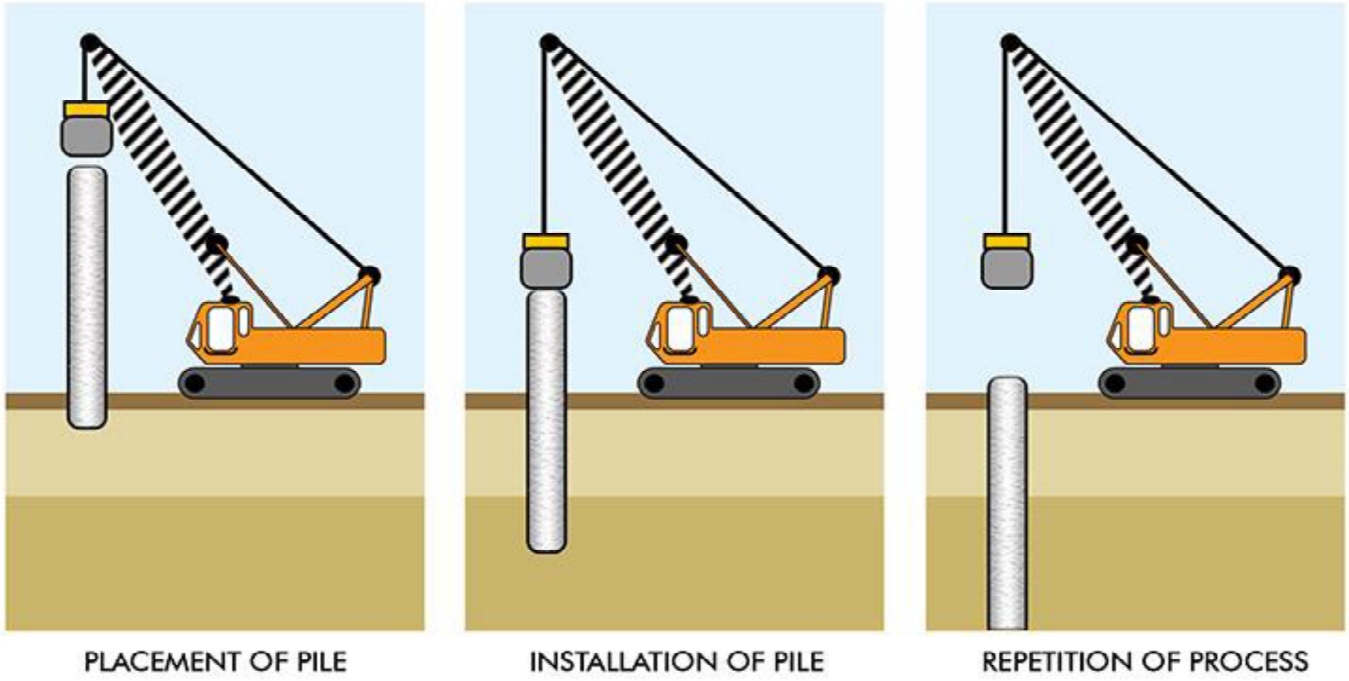
Protection of adjoining structure during excavation using steel sheet piles and bracings

Safety of Pile rig

- Erection of pile rig: The frame of the rigs shall be structurally safe for all anticipated dead, live and wind loads.
- Operation of pile rig: Access to working platforms and top of pulley shall be provided by ladders. Working platforms shall be protected from wind and rain.
- Piles: Piles shall be prepared at a distance at least equal to twice the length of the longest pile, from the pile driver.
- Inspection and tests: Pile driving equipment shall be inspected by an engineer at regular intervals not exceeding three months.



Automated Pile driving of Bored Pile



Automated Installment of precast pile

Safety For Formwork and Scaffold

- **Scaffold and centering materials**: Horizontal and inclined bracings shall be provided for posts higher than 3 m. Spans of beam bottoms shall be supported by posts at most 1 m apart if steel is used. All scaffolding exceeding 20 m or six stories in height shall be constructed of noncombustible or fire-retardant materials.
- **Steel centering**: Struts and diagonal braces shall be in proper position and secured.
- **Formwork for concrete**: In case of removal of roof shuttering, staging has to provide below the roof.
- **Load capacity**: Weight of wet concrete: 20 kN/m^3
- **Bamboos**: Bamboos for vertical support shall not be less than 75 mm in diameter.
- **Timber posts**: Timber posts shall be used in supporting formwork up to a height of 6 m.

Timber formwork with vertical supports of a column to ensure safety

Steel formwork with horizontal supports of a beam to ensure safety

Safety During Concrete Work

- **Pre-stressed concrete**: No person shall stand in line with the tensioning elements and jacking equipment during the tensioning operation. Also no one shall be directly over the jacking equipment when deflection is done. Workmen shall be prevented from working behind the jacks when the tensioning operation is in progress by putting signs, barriers, or protective shields.
- **Concrete mixers:** All gears, chains and rollers of mixer plants shall be guarded. All cables, clamps, hooks, wire ropes, gears, clutches, etc. of the mixer shall be checked and serviced once a week.
- **Concrete trucks and buckets:** A reasonably smooth traffic surface shall be provided for concrete trucks. Closing and locking of the exit door of the concrete bucket shall always be checked.

Tensioning operation is being conducted using protection

Safety During Construction of Floors

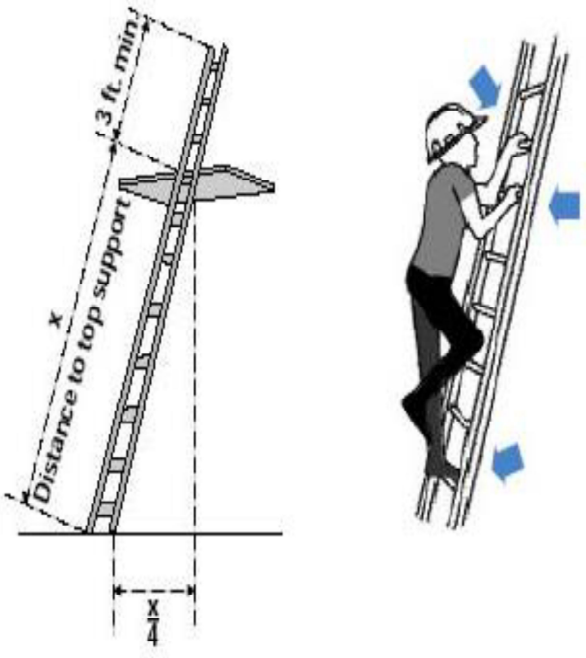
- Use of sheets: Joints in corrugated galvanized iron sheets are kept secured.
- Platforms: Working platform required according to the type of roof shall be provided.
- Flat roof: The formwork shall be frequently inspected for defects. Enough walking platforms shall be provided in the reinforcement area.
- Openings and holes: Every temporary floor opening shall either have railing of at least 900 mm (3 ft) height, or shall be constantly attended.

Railing to ensure safety for floor opening

Safety During Construction of Walls

- **Scaffold**: The scaffold has to check after every 15 days in rainy season and 30 days in dry season.
- **Ladders**: Rails of ladders shall extend at least 1m above the landing. A lean-to-ladder shall have a maximum angle of 75° with the horizontal. A user shall place his feet near the ends of the rungs rather than near the middle, and face the ladder when using it. Leaning more than 300 mm from the side shall not be allowed.
- **Opening in walls**: wall opening from which there is a vertical drop of more than 1200 mm shall be guarded by barriers.
- **Projection from walls**: Formwork provided for horizontal projections shall not be removed till protection against overturning are constructed.
- Overhead protection against the falling materials shall be provided.

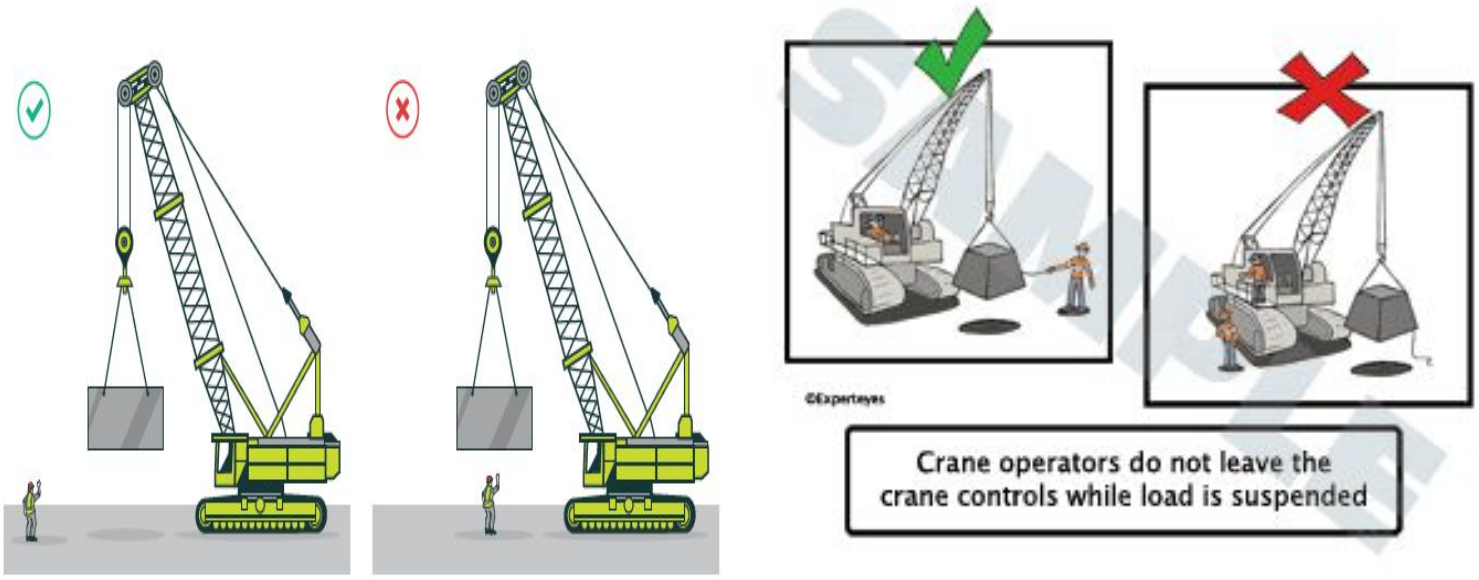
Scaffold during construction of walls to ensure safety of workers



Rules of using ladder according to California Code of Regulations, Title 8; to ensure ladder safety

Safety During Erection Operations

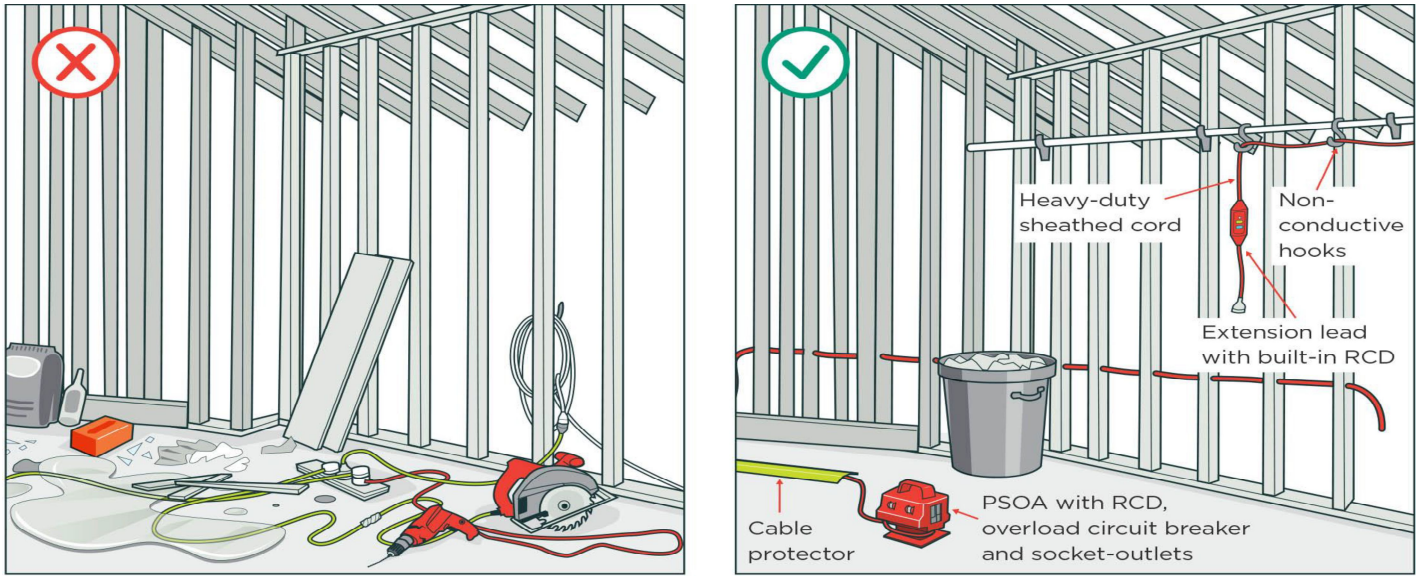
- **Erection and hoisting**: Ropes in operation shall not be touched. The ropes shall be chemically treated to resist dew and rotting. They shall not be tied beyond the reach of safety belts complying to BDS 1359.
- **Small articles**: Bolt baskets or similar containers with handles shall be provided on floats or scaffolds where small material, such as bolts and drift pins are used.
- **Hoist protection**: A material hoist shall not be used to transport workers; temporary elevators shall be installed, if necessary.
- **Lifting gear**: Lifting gears must be tested and examined by a competent person.
- **Cranes**: The safe working load shall be clearly shown on the crane. Cranes shall not be operated in proximity to a live overhead power line. no person under the age of 21 years shall be allowed to operate.



Safety measures to be taken during erection using crane

Electrification, Equipment and Operations

- **Wiring system**: No scaffolding, ladder, working platform, gangway, runway, etc. within 3 m of an un-insulated live electric wire. The main switch board shall be located in an easily accessible and prominent place. One CO2 extinguisher or one 5-kg dry powder extinguisher, shall be provided near the switch board.
- **Guarding of cables**: All cables and signal cords shall be guarded wherever pass through or cross working spaces.
- **Lifts**: Entry to the empty lift well shall be blocked. Notices/signs shall be displayed in the lift lobby when the lift is not in operation.



Ensuring safety during electrification

Electrification, Equipment and Operations

- **Construction machinery**: Exhaust of petrol or diesel powered machinery shall be well away from combustible materials. All sources of ignition shall be banned near petroleum- fired equipment.
- **Flame cutting and welding**: For all arc welding work, either a helmet or a hand-held face shield conforming to BDS 1360 shall be used. When slag is being removed from weld by clipping, the eyes shall be protected by goggles conforming to BDS 1360.
- **Riveting operation**: Rivets shall be carefully handled to prevent accidental fall.

Items required for welding operation to ensure safety

Protection of Public

- Adjoining property: No part of any structure, except signs, shall project beyond the property line.
- Protective fences and railings: Railings, adjacent to footpath or excavation, shall be at least 1m in height. Work within 1.5 m from the road shall be enclosed with a fence not less than 2.4 m high
- Canopies, overhangs and platforms: Protective canopy shall width shall not be less than 1.2 m wide. Braced and designed to support at least 7 kPa.
- Protection of utilities: Protective frame and boarding shall be built. Precaution to be taken to prevent material blocking a sewer.

Protection of adjoining building

Use of guard rail

Protection of Public

- Notices and signs: Outer edge shall have red lights which shall flash continuously day and night.
- Watchman and auditory signals
- Safe load: Strength test to two and half times the superimposed live load.

Examples of notices and signs during construction

Environmental Protection of Public

- Protection of Existing Drainage Systems and Utilities
- Protection of Soil, Aquifers, and Water Channels: Safe transportation and disposal of all wastes. Shall not allow waste oils or other petroleum derived wastes to be used as dust suppressants. Adequate sanitary facilities for workers.
- Protection of Air Quality: Measures to minimize dust-blow by regular watering.
- Protection from Sound Pollution: Noisy activities shall not be carried out from 18.00 pm in the evening to 06.00 am in the morning and on non-working days and holidays in residential areas.

Safety of Workers

- First aid attendant: At least one person trained in first aid for every 100 workers. Shall have a refresher course every five years and certificates renewed.
- Preconstruction Phase:
  - Site access, protected storage, protection of personnel, maximization of activities during fair weather, special provision for activities in extreme temperature, adequate lighting.
- Construction Phase:
  - Organizational structure, site layout, access for fire-fighting vehicle, construction strategy and sequence

Safety of Workers

- Temporary buildings: site office and shelter for workforce with use of non-combustible materials including emergency medical aids.
- Construction safety with emergency access and evacuations and security measures.
- Manual Handling: Each workman shall be provided with suitable equipment for his personal safety as necessary.
- Protection against Fire: Combustible materials separated. Two types of DCP extinguishers at both open and covered locations.

Equipment of workers to ensure protection against fire

Safety of Workers

- Safety of workmen: Helmets conforming to BDS 1265 and BDS 1266; Safety goggles of accepted standard (BDS 1360). Proper protective equipment like gloves, safety boots, aprons and hand shields
- Site amenities: Toilet facilities shall be provided at all construction sites. Washing facilities and Drinking water shall be provided.
- Health hazard: Mechanical ventilation shall be provided if there is gas/fume.
- Common hazards during walling: overhead protection against the falling materials shall be provided.

Safety Against Construction Hazards

- **Fire hazards**: Ground below the scaffolding shall be kept free from readily combustible materials. Portable dry powder extinguisher of 3 kg capacity shall be kept near all flame producing equipment.
- **Health hazards**: Exhaust ventilation shall be employed in enclosed spaces. Wearing of loose garments shall be strictly avoided. In case of a site where more than 600 workmen are employed at any one time, or in which more than 300 workmen are employed at any one time and is 15 km from the nearest health service facility, provision of an ambulance shall be made.
- **Skin hazard**: Workmen engaged in works which may splash liquid or other materials liable to injure the skin shall have enough protective clothing to cover the body and limbs.
- **Noise hazard**: For levels up to 110 dB, properly fitted ear plugs shall be provided. Exceeding 120 dB, noise protection helmets shall be provided.

(a)

(b)

(c)

a) Equipment required to avoid fire hazard in construction site, b) Some common health hazard due to construction work, c) an example of skin hazard

Cement Storage

- To be stored at the work site in a building or a shed which is dry, leak proof and moisture proof.
- Bags to be stacked on wooden planks maintaining a minimum clearance of 200 mm from the floor.
- Maximum height of the stack shall be 15 bags and the width not more than four bags or 3m.
- In stacks more than 8 bags high, the bags shall be arranged alternate length and crosswise.
- Cement shall be used in the order they are received; storage shall facilitate this requirement.
- Hooks shall not be used.
- Workers handling cement shall put on protective hand and face coverings.

Cement bags are arranged alternate length and crosswise for 8 or more row stacking

Steel Storage

- Reinforcement bars and structural steel sections shall be coated with cement wash before stacking.
- Bars of different types, sizes and lengths and structural steel sections shall be stored separately to facilitate issues.
- Ends of bars and sections of each type shall be painted with separate designated colors.

Brick Storage

- The stacks shall be 50 bricks long and 10 bricks high and not more than 4 bricks in width.
- Clear distance between adjacent stacks shall be not less than 800 mm.
- Bricks made of clay containing lime shall be thoroughly soaked in water.
- The height of the stack of blocks shall not be more than 1.2 m, the length of the stack shall not be more than 3.0 m.
- All blocks should be water cured for 10 to 14 days and air cured for another 15 days; thus no blocks with less than 28 days curing shall be used.

Images for brick and block storage

Demolition Work

- Precautions During Demolition:
  - Sequence
  - Walls, Floors, Special elements
  - Mechanical demolition
- Blasting Operation and Use of Explosives:
  - Code of signal
  - Supervision and responsibility
  - Protection of site personnel
  - Safety of third parties
  - Use of explosives
- Lowering, Removal and Disposal of Materials should be made carefully

Chutes is being provided from more than 45 degree angle during demolition work

Miscellaneous

- Mechanical demolition shall be restricted to a height of 25 m. No person shall be allowed to enter the building.
- No demolition work shall be carried out at night, or during storm or heavy rain. If demolition has to be done at night, precautions in the form of red warning signals, sirens, working lights and watchmen shall be provided. Auditory warning devices shall be installed at the demolition site.
- Precautions shall be taken to avoid overloading of the floor with debris.

Summary

We have learnt

- The necessity of construction safety
- The stages of construction and safety protocol during each stage
- How to ensure safety of public during the construction
- How to ensure the safety of workers during construction
- How to store the construction materials
- How to ensure safety during demolition work

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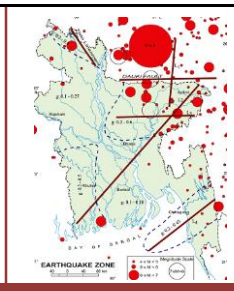

Lesson Seven

Earthquake management planning and preparedness

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About the Lesson

- This lesson aims to provide better understanding about earthquake management planning and preparedness.
- At the end of the lesson we would learn
  - ✓ Different levels of earthquake management plan.
  - ✓ Example of management plan in local context.

Introduction

- Earthquake Management Plan covers all phases of earthquake management right from mitigation, preparedness, emergency response, relief to recovery.
- The plan discusses the roles and responsibilities of different stakeholders and it provides a guideline to all the concerned line departments to get prepared and to play their critical roles and responsibilities.
- Earthquake Management Plan is also crucial to achieve the global targets under The Sendai Framework for Disaster Risk Reduction 2015-2030 (GSDMA, n.d).

Introduction

Components of earthquake management planning and preparedness

- Structural and non-structural mitigation measures:
  - ✓ Earthquake resistance design for different seismic zones
  - ✓ Retrofitting of existing structure
  - ✓ Removal of unsafe buildings
  - ✓ Capacity building and awareness raising measures etc.
- Preparedness measures
  - ✓ Identify safe schools and colleges which can be used as relief shelters for short duration of time in aftermath of any earthquake.
  - ✓ Prepare a database of registered private hospitals, clinics, diagnostic labs, blood banks, etc. along with their capacities and facilities
  - ✓ Prepare for arrangement of safe drinking water supply for community in the affected areas, relief camps and shelters (GSDMA, n.d).

Introduction

Components of earthquake management planning and preparedness

- Earthquake Response and Relief measures:
  - ✓ Prepare activities and roles with respect to time frame of all the stakeholders need to be taken in aftermath of an earthquake.
  - ✓ Prepare an evacuation route to ensure that people at threat are moved to a safe location
  - ✓ Identify and properly record the dead bodies and facilitate the appropriate cremation/ burial
  - ✓ Address all basic needs of the affected population in the relief camps
  - ✓ Provision of emergency medical and mental health assistance etc. (GSDMA, n.d).

Introduction

Level of earthquake management planning and preparedness

National Level

- National contingency plan generally addresses more than one disasters including all potential hazards.
- Evaluation of the capacity of national set-up and description of the approach to be taken for emergency response nationally are focused here.

City Level

- The plan area is demarcated based on the needs, type and geographical context of a city
- To reduce vulnerability of urban area.

Community Level

- Local community can provide great deal of information regarding their own risks and capacities; these are brought under consideration in community level contingency plan.\
- Components of plan and institutional set up are decided based on community consultation and local context.

(International Federation of Red Cross and Red Crescent Societies, 2012)

Introduction

Involvement of institutions in planning and preparedness

- Developing a plan is a teamwork.
- Input and support from a variety of people will provide crucial assistance to those who are doing the planning.
  - ✓ In different positions e.g. governance, senior managers, sectoral technicians, volunteers, administrative personnel, logisticians, etc.
  - ✓ From different levels (local, national and regional/global)
  - ✓ From external partners e.g. government, UN partners, NGOs, etc.
- Planning is most effective when it is a participatory process that (ideally) includes all the actors who will be required to work together in the event of an emergency (IFRCRCS, 2007).

DMP: National level

Regulatory framework

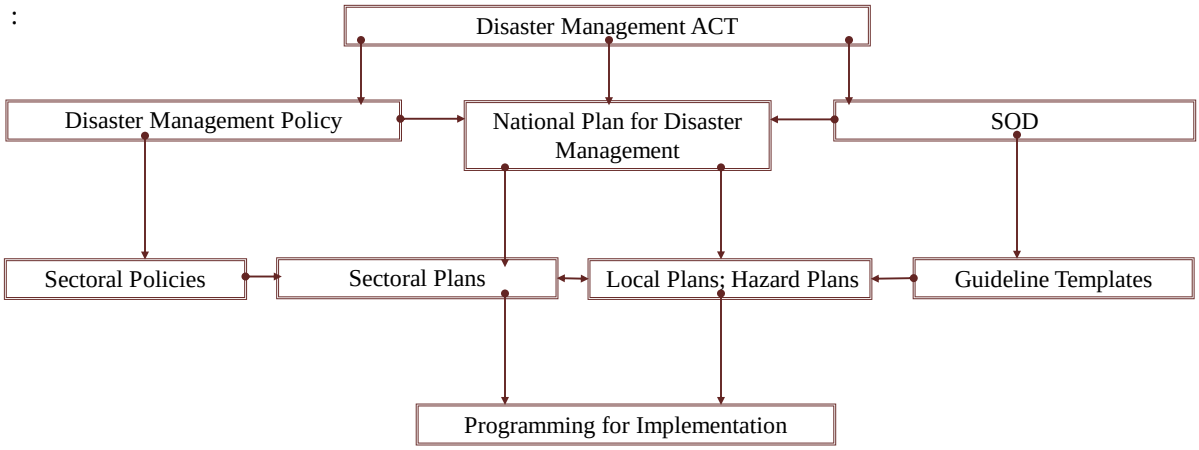
- To reduce the vulnerability of people, especially the poor, to the effects of natural, environmental and human induced hazards to a manageable and acceptable humanitarian level.
- In order to manage the paradigm shift in disaster management, a disaster management regulatory framework is established under which the Bangladesh Disaster Management Framework is implemented.
- The regulatory framework provides the relevant legislative and policy under which the activity of Disaster Risk Reduction (DRR) and Emergency Response Management (ERM) in Bangladesh is managed and implemented (Government of Bangladesh, 2019).

DMP: National level

Regulatory framework

According to SOD, 2019 the framework is comprised of:

:



DMP: National level

Focus of Earthquake in Regulatory Framework

- National Plan for Disaster Management 2010-2015 emphasizes for the preparation of earthquake contingency plan.
- Response operations in functional clusters are recommended to be included in contingency plan
- In this approach, under National Earthquake Contingency Plan, all response activities are grouped into nine relevant operational functional clusters based . The clusters are as follows:
  - ✓ Emergency Operations Cluster 1 – Overall Command and Coordination
  - ✓ Emergency Operations Cluster 2 – Search, Rescue and Evacuation
  - ✓ Health Cluster
  - ✓ Relief Services (Food, Nutrition and other Relief) Cluster
  - ✓ Shelter (Including Camp Management) Cluster
  - ✓ Water Supply, Sanitation and Hygiene Cluster
  - ✓ Restoration of Urban Services Cluster
  - ✓ Transport (Road, Rail, Air, Sea) Cluster
  - ✓ Security and Welfare Cluster (National Plan for Disaster Management 2010-2015, 2010)

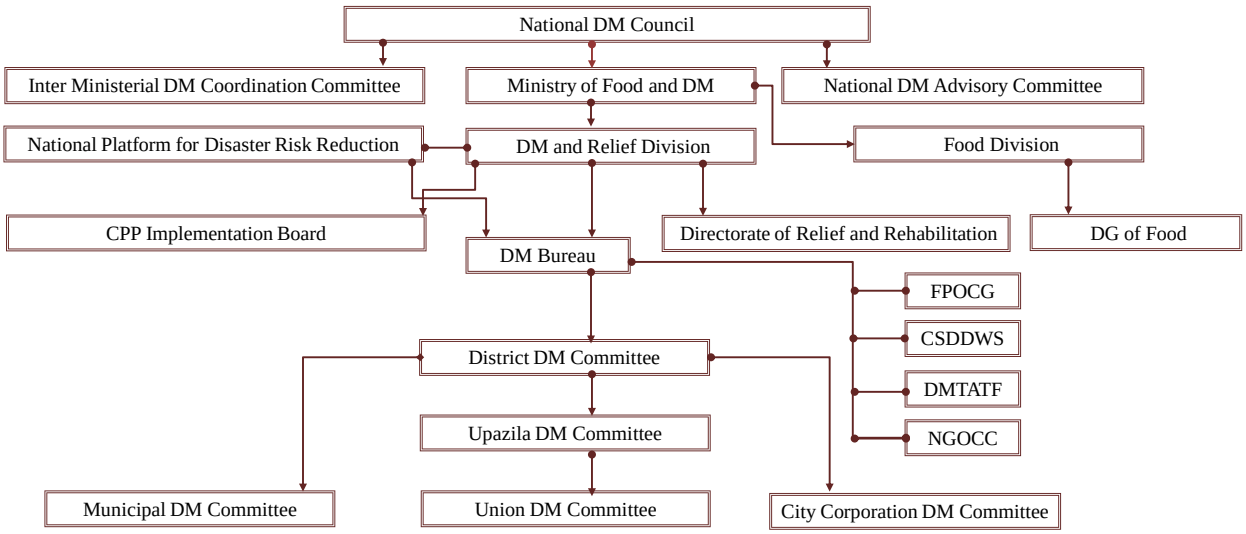
DMP: National level

Focus of Earthquake in Regulatory Framework

- In SOD, the formation, organogram and responsibilities of Earthquake Preparedness and Awareness Committee are elucidated.
- SOD articulates responsibilities of different authorities and stakeholders in
  - ✓ Earthquake contingency plan preparation
  - ✓ Vulnerability assessment
  - ✓ Research for earthquake management
  - ✓ Capacity building
  - ✓ Awareness raising
- SOD emphasizes on the integration of earthquake risk in land use planning.
- One of the priority activities listed in the National Disaster Management Policy 2008 to establishing a Contingency Planning framework.

DMP: National level

Institutional arrangement (Source: Government of Bangladesh, 2019).



DMP: City level

Components of city level plans

- Risk in urban areas is a combination of two factors:
  - first, location and exposure to hazards; and
  - second, increased vulnerability due to poor local governance, environmental degradation, and the overstretching of resources
- A competent lead/focal person/organization is critical to the success of the planning process.
- Consider carrying out disaster risk management and planning through partnerships, including multi-level partnerships, multi-sector partnerships and public-private-civil society partnerships.
- Support from national government, particularly in providing an enabling environment for DRR is essential for a successful planning and implementation process.
- Commitment from local government is another key ingredient for successful planning and implementation.
- DRR planning must go hand in hand with capacity development efforts (APDC, 2010)

DMP: City level

Example

Dhaka Earthquake contingency plan

- Earthquake Contingency Plan for Dhaka City ,2010 has been prepared under CDMP by GoB
- Different aspects of earthquake management have been explained under nine (09) clusters
  - ✓ Command and coordination,
  - ✓ Search, rescue and evacuation,
  - ✓ Health,
  - ✓ Relief and shelter,
  - ✓ Utility services
  - ✓ Restoration of urban facilities etc.
- Three (03) categories agencies based on priority responding and activities
  - ✓ First responder organization mainly government agencies,
  - ✓ Second responder organization incorporated utility services providers
  - ✓ Third responder organization includes NGOs, CBOs and others (CDMP, 2009)

DMP: City level

Example

CDMP-II

CDMP has initiated its phase-II (CDMP-II) for carrying out similar earthquake risk and damage assessment and subsequent development of scenario based Contingency Plan for Rangpur, Dinajpur, Mymensingh, Tangail, Bogra and Rajshahi Municipalities/ City Corporations areas. Common features of these planning:

- Follows the principles of scenario based earthquake contingency planning
  - ✓ Scenario-1 An earthquake of 43 years return period originated from Dauki Fault with 7.9 Ms
  - ✓ Scenario-2 An earthquake of 475 years return period originated from Dauki Fault with 7.9 Ms
  - ✓ Scenario-3 An earthquake of 2475 years return period originated from Dauki Fault with 7.9 Ms
- Probabilistic earthquake risk assessment is carried out using HAZUS model for analyzing potential damages and losses from different earthquake scenarios.
- Estimates resource needs and analyze Resources Availability (CDMP II, 2014).

DMP: City level

Example

CDMP-II

- The earthquake response operation in the town is carried out through a Town-level response framework to standardize the activities of first responder agencies
- The basis of this response framework will be the establishment of a multi-tiered Town-level Emergency Operation Center (EOC) and functional response cluster system.
- Cluster-wise action strategies comprising detailed activities before, during and after a major earthquake in Tangail Municipality area and responsible lead and support agencies are described.
- Priority actions at the initial response phase, priority actions at the intermediate response phase, and priorities actions at the initial recovery phase are determined (CDMP II, 2014).

DMP: Community level

Definition

- **Community-based Disaster Risk Management** (CBDRM) is a process in which at-risk communities are actively engaged in the identification, analysis, treatment, monitoring and evaluation of disaster risks in order to reduce their vulnerabilities and enhance their capacities.
- It empowers people to address the root causes of vulnerabilities by transforming social, economic and political structures that generate inequality and underdevelopment (ADPC, 2006).
- Factors influencing for the sustainability of CBDRM:
  - ✓ "Culture of coping with crisis" and " culture of disaster reduction"
  - ✓ Well-delivered training inputs in accordance with the objectives of the project and the needs of the community for training
  - ✓ Participation of people and incorporating their perception of vulnerability and capacity
  - ✓ Wide stakeholder's involvement and participation
  - ✓ Effective networking and knowledge capitalization
  - ✓ Accumulation of physical, technological and economic assets to reduce vulnerability (Shaw, R. and Okazaki, 2004).

DMP: Community level

Importance of community involvement in earthquake management

- Active participation of community is considered as an integral part of a well organized disaster management of a country (Wells et.al, 2013; Victoria, 2009; Pandey & Okazaki, 2005; Samaddar & Okada, 2006).
- It is very tough for government authority to tackle the disaster alone thus there needs for a good linkage with the community (Raungratanaamporna, Pakdeeburee, Kamiko & Denpaiboon, 2014).
- Community participation in managing earthquake at different times at different countries is exemplary.
  - ✓ After Kathmandu earthquake April 2015, community people responded first for immediate rescue of family members and neighbors from collapsed buildings and providing emergency services.
  - ✓ After Kobe earthquake in 1995 in Japan, most of the victim's voiced that they rescued and helped mainly by their neighbors before the authorities' arrival (Twigg & Mosel, 2017).

DMP: Community level

International strategies on the importance of community involvement in disaster management

Table 1: Incorporation of community in international strategies (Source: UNISDR, 2005).

Hyogo Framework of Action (HFA) (2005-2015)	Sendai Framework of Action for DRR (2015-2030)
Empowering the communities with the local authorities through proper access to information, resources etc.	Inclusive policies for disaster management where community involvement is a must
Awareness raising activities and capacity building measures for the community has been promoted to build up resilient disaster prone developing countries at all levels.	4th priority of action where disaster preparedness is the prime concern to **"Build Back Better"** in recovery, rehabilitation and reconstruction
	Participation from national level, civil society, communities, volunteers and so on.

DMP: Community level

Examples (CBDRM)

Philippines Earthquake Risk Management Project

- **Major activities include:**
  - ✓ Community Participation and Involvement;
  - ✓ Early Warning and Communication;
  - ✓ Community Mobilization and Information Dissemination Disaster Rescue;
  - ✓ First Aid and Retrieval;
  - ✓ Engineering and Infrastructure Support;
  - ✓ Capacity Building and Training.
- **Major lessons :**
  - ✓ People act more decisively when they fully understand the nature of hazards or when affected by the hazards.
  - ✓ Institutionalizing the community and the private sectors can result in more sustainable DMP
  - ✓ Disaster management programs and activities are successful when they are part of the socio-economic development efforts of the community (Shaw, R. and Okazaki, 2004).
  - ✓ Transparency is a key factor in order to obtain community support and participation
  - ✓ Private or business sectors can be effective leaders to initiate projects

DMP: Community level

Examples (CBDRM)

Kathmandu Valley Earthquake Risk Management Project

- **The activities included**:
  - ✓ Raised Awareness and Changed Mindset;
  - ✓ Establishment of a System of Retrofitting;
  - ✓ Establishment of the Nepal Forum for Earthquake Safety (NFES);
  - ✓ Implementation of Building Code;
  - ✓ Demand for Academic Courses in DM and Vulnerability Reduction (Shaw, R. and Okazaki, 2004).

- **Major lessons:**
  - ✓ Organizations and individuals to understand their roles and responsibilities in CBDRM projects.
  - ✓ Transparency of activities and dissemination of knowledge encourage people's participation in activities.
  - ✓ Raising awareness is a crucial component in every activity and project
  - ✓ CBDRM efforts need stable financial resources
  - ✓ What is accepted by the community' is more important than 'what is necessary' (Shaw, R. and Okazaki, 2004).

DMP: Community level

Examples (CBDRM)

Bengkulu, Indonesia CBDRM project

- **Major activities include:**
  - ✓ Public awareness activities;
  - ✓ Training on structural mitigation and non-structural mitigation;
  - ✓ Earthquake resistant school prototype design;
  - ✓ Building an earthquake resistant simple house
- **Major lessons**:
  - ✓ A community with a recent experience of disaster is more receptive to CBDRM initiatives
  - ✓ Strong leadership and political support from the Mayor is important
  - ✓ Establishment of networks among various organizations and institutions is a key element
  - ✓ It is necessary to change most people's belief that 'emergency response' is more important than 'mitigation' (Shaw, R. and Okazaki, 2004).

DMP: Community level

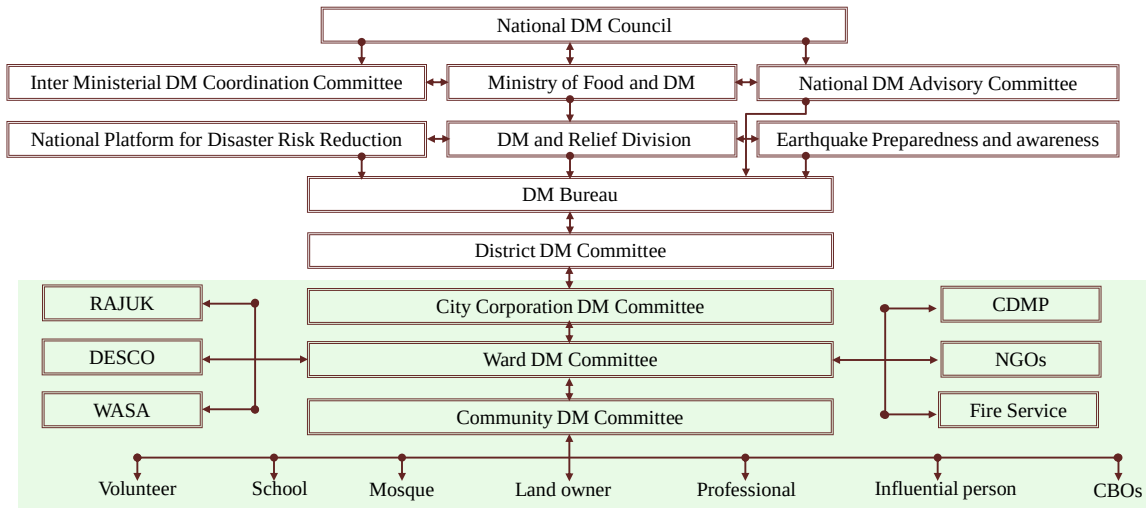
Link of community with the institutional set up of SOD

- According to the DM legislations, there is a structured regulatory framework and institutional setup for DM in Bangladesh.
- In urban areas, DM at local level is limited to ward level; SOD doesn't specify how community based DM approach can be implemented through DM legislations (SOD, 2019).
- People living in the community have more knowledge about their own vulnerability and capacity.
- Moreover, at the event of any disaster, local community people not only play the role of victims but can also work as first responders to initiate the response and relief activities before the professionals reach the place for help.
- It is insufficient to manage a disaster through top-down approach using government and institutional interventions alone.
- Local communities are often either unaware of these formal DM interventions or they find the interventions inappropriate to them.
- It is very essential to include community people in the DM process (Rahman et al., 2018).

DMP: Community level

Link of community with the institutional set up of SOD

Rahman et al, (2018) proposed a institutional set up to include community in DMP in Bangladesh.



DMP: Community level

Understanding risk at community

- It is a process to identify the risks that community people, villagers face and how people overcome those risks.
- This process involves hazard assessment, vulnerability assessment and capacity assessment, and analysis and prioritization of risks (Kafle and Murshed, 2006).

- **Tools for understanding risk**
  - ✓ Participatory Rural Appraisal (PRA)
  - ✓ Informal interview
  - ✓ Secondary data

DMP: Community level

Understanding risk at community

Participatory Rural Appraisal (PRA)

Table 2: Different tools of PRA used in understanding risk (Kafle and Murshed, 2006).

Tool	Purpose
Historical Profile	To get insight in past hazards nature, intensity and behavior
Transect Walk	To identify danger zones, evacuation sites, local resources used during emergency periods, etc
Seasonal Calendar	To identify periods of hazards, diseases, hunger, vulnerability, etc; To identify what people do in these periods, how they diversify sources of livelihood, when do they have savings, when do they have time for community activities, what are their coping strategies
Resource Mapping	To identify available local capacities and resources people rely on in times of disasters; To identify which resources are easily affected by disasters and which resources accessible and owned by community, or individuals.
Institutional & Social Network Analysis	To identify organizations (local & outside), their role/importance, and perceptions that people have about them; To identify individuals, groups, organizations that play a role in disaster response and can support the community

DMP: Community level

Understanding risk at community

Participatory Rural Appraisal (PRA)

Table 2: Different tools of PRA used in understanding risk (Kafle and Murshed, 2006).

Tool	Purpose
Problem tree	Top identify local major problems and vulnerabilities as well as root causes and effects
Daily Routine Analysis	To determine when the community members are available for risk reduction activities such as training, meetings, etc.; identify roles played in disaster risk management activities
Matrix Ranking and Scoring	To identify criteria and determine preference; to identify differences in perceptions and reasons; to encourage problem solving through discussion and ranking the problems and the solutions.

DMP: Community level

Understanding risk at community

Informal interview

- Informal interviews are discussions in an informal way. No formal questionnaire is used, but at the most a checklist of questions as a flexible guide.
- It is needed to get information, to analyze problems, vulnerabilities, capacities and perceptions, to discuss plans, etc.
- There are different types of informal interviews:
  - ✓ Group interview: to obtain community level information, to have access to a large body of knowledge, not useful for sensitive issues
  - ✓ Individual interview: to obtain representative, personal info. May reveal differences or conflicts within community
  - ✓ Focus group discussion: to discuss specific topics in detail with a small group of persons who are knowledgeable or who are interested in the topic. People can also be grouped according to age, owners of resources (Kafle and Murshed, 2006).

DMP: Community level

Understanding risk at community

Informal interview

- ✓ Key-informant interview: to obtain special knowledge about a particular topic; you interview a nurse if you want to know more about epidemics, a farmer about cropping practices, a villagen leader about procedures and policies (Kafle and Murshed, 2006).

Figure 1: Consultation workshop with the local people in Mymensingh-ward 14
(Source: BUET-JIDPUS, 2018).

DMP: Community level

Understanding risk at community

Secondary data collection

- In Secondary Data Review existing information can be collected about:
  - ✓ Background information on community (census, research findings, reports, etc)
  - ✓ Possible threats to the community
  - ✓ Scientific information about hazards or threats
  - ✓ Case studies about hazards and threats in other communities
  - ✓ Relevant legislation and policies regarding disasters
- It is needed to get an overview of the situation and context; to save time; to learn from experiences elsewhere (Kafle and Murshed, 2006).

DMP: Community level

Assessment of vulnerability

This section is elaborately discussed in **"Earthquake Vulnerability Assessment"** lesson of this Module.

DMP: Community level

Steps of DM plan at community level

1. Selecting the Community

- The selection of communities for implementation of CBDRM activities mainly depends upon the risk exposure of the particular community.

2. Rapport Building and Understanding

- It would be important to understand the local social relationships and power structures, key economic groups and to build good informal relationship with the local people.
- If community members have trust in the outsiders who are working with them, then open sharing about issues, problems, concerns and solutions can take place.

3. Participatory Disaster Risk Assessment

- This process involves hazard assessment, vulnerability assessment and capacity assessment, and analysis and prioritization of risks.
- The participatory disaster risk assessment will be conducted by the local authorities with the involvement of local people, community leaders and subject experts (Kafle and Murshed, 2006).

DMP: Community level

Steps of DM plan at community level

4. Community-based Disaster Risk Management Planning

- The community members in collaboration with other stakeholders identify activities to mitigate the hazards.
- The group can identify the various resources of the community and further discuss about the additional resources needed for implementation of risk reduction activities
- After the prioritization of risk reduction measures and identification of resources, the group should assign responsibilities to various stakeholders on who will do what with a realistic time frame.

5. Community Managed Implementation

- The implementation of the plan should be done through the community organization with support from local authorities and technical and research institutions.
- The implementation process will include various structural and non-structural activities; e.g. community training, disaster response drills, community early warning systems, disaster resilient construction of houses.

6. Monitoring & Evaluation

- Participatory monitoring and evaluation involves the local community, development and local authorities and other stakeholders in measuring the progress made, and identifying necessary follow-up actions (Kafle and Murshed, 2006).

Household preparedness

What is household preparedness?

- Preparedness is defined as the activities and measures taken in advance to ensure effective response to the destructive impacts of disasters.
- The preparedness actions may include collecting survival items, planning what households do at the time of earthquakes, and mitigation activities (Ardalan & Sohrabizadeh, 2016).
- Preparing for earthquakes involves learning what people should do before, during, and after earthquakes; and doing or preparing to do those things now, before the next quake (FEMA, 2020).

Importance of household preparedness

- One need to be ready to respond earthquake, as local responders may not be able to reach immediately or they may need to focus their efforts elsewhere.
- The negative consequences of earthquakes can be reduced by preparing households appropriately.
- At the individual level, the preventive measures increase coping capacity as well as community resilience for recovering from the ramifications of quakes .
- A prepared household can take care of itself for the **first seventy two hours** after an earthquake.
- Households, as the first responders, usually focus on restoring lifelines and the most acute rescue needs prior to the arrival of outside assistance (Ardalan & Sohrabizadeh, 2016).

Household preparedness

Stages of household preparedness

- Before an earthquake (Prepare)
- During an earthquake (Survive)
- After an earthquake (Recover)

Household preparedness

Before an earthquake (Prepare)

- Secure your space by identifying hazards and securing moveable items.

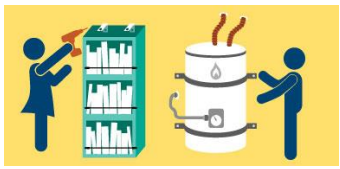


Figure 2: Secure your space (ECA, 2020).

- Plan to be safe by creating a disaster plan and deciding how you will communicate in an emergency

Figure 4: Create Disaster plan (ECA, 2020).

- Organize disaster supplies in convenient locations.

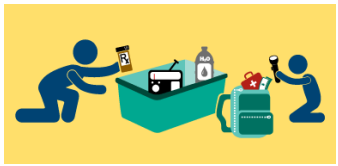


Figure 3: Organize disaster supplies(ECA, 2020).

- Minimize financial hardship by organizing important documents, strengthening your property, and considering insurance (ECA, 2020).

Figure 5: Minimize financial hardship (ECA, 2020).

Household preparedness

During an earthquake (Survive And Recover)

- DROP where you are onto your hands and knees. This position protects you from being knocked down and also allows you to stay low and crawl to shelter if nearby.
- COVER your head and neck with one arm and hand
  - ✓ If a sturdy table or desk is nearby, crawl underneath it for shelter
  - ✓ If no shelter is nearby, crawl next to an interior wall (away from windows)
  - ✓ Stay on your knees; bend over to protect vital organs
- HOLD ON until shaking stops
  - ✓ Under shelter: hold on to your shelter with one hand; be ready to move with it if it shifts
  - ✓ No shelter: hold on to your head and neck with both arms and hands.
- Improve safety after earthquakes by evacuating if necessary, helping the injured, and preventing further injuries or damage (ECA, 2020).

Figure 6: Drop, Cover, and hold on(ECA, 2020).

Figure 7: Improve safety (ECA, 2020).

Household preparedness

After an earthquake (Recover)

- Although aftershocks are less strong than the main shock, they may cause additional damage. Do not go out until there is an emergency.
- Reconnect and Restore: Restore daily life by reconnecting with others, repairing damage, and rebuilding community.
- Stay away from damaged areas: Stay away unless your assistance has been specifically requested by police, fire, or relief organizations. Return home only when authorities say it is safe (ECA, 2020)

Figure 8: Reconnect and Restore (Source: ECA, 2020)

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Thank You

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Earthquake Risk Assessment for Developing Contingency Plans, Training Modules and Awareness Materials for Rangpur City Corporation and Tangail, Rangamati and Sunamganj Pourashavas

Conducted by
BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS)
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Department of Civil Engineering
Bangladesh University of Engineering and Technology (BUET).

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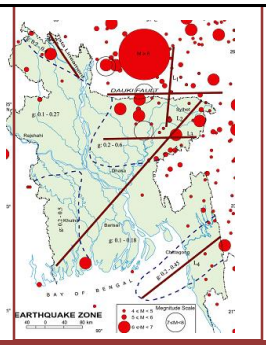

Lesson Eight

Contingency or Emergency planning

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About the Lesson

- This lesson aims to provide better understanding about earthquake contingency planning.
- At the end of the lesson we would learn
  - ✓ Objectives and scopes of earthquake contingency planning.
  - ✓ Data requirement for earthquake contingency planning.
  - ✓ How to collect data for earthquake contingency planning.
  - ✓ How to prepare earthquake contingency planning.

Contingency Planning

- Contingency planning is a **course of actions** which aim to prepare an entity to respond well to **an emergency** and its potential humanitarian impact (CDMP,2014).
- It is a **management tool**, to ensure **timely and effective provision of humanitarian aid** to the affected ones.
- **Contingency Planning** is a **forward planning process**, in which
  - ✓ Possible scenarios and objectives are developed
  - ✓ Managerial and technical actions are put in place
  - ✓ Potential response systems are designed in order to prevent and respond to an emergency or critical situation (CDMP, 2009a).

Contingency Planning

- The process tries to answer the following questions:
  - ✓ What is going to happen?
  - ✓ What are we going to do about it?
  - ✓ What can we do ahead of time to get prepared?
- There is no hard and fast rule for contingency planning.
- Planning priorities will differ according to the context and scope of any given situation.
- Based on seismic, structural and socio-economic vulnerability of the area, an earthquake contingency plan was prepared.

(International Federation of Red Cross and Red Crescent Societies, 2012 ;CDMP, 2009a)

Contingency Planning

- During an actual emergency, rapid and effective action is required.
- So contingency plans must be in place before a disaster strikes – along with the necessary resources.
- If appropriate action is not taken or if the response is delayed, lives may be needlessly lost.
- Contingency planning should always be undertaken when there is a high risk or probability that a disaster or emergency situation may occur.

Time spent in contingency planning = Time saved when a disaster occurs

(International Federation of Red Cross and Red Crescent Societies, 2012 ;CDMP, 2009a)

Need for Contingency Planning in Bangladesh Context

- One of the priority activities listed in the National Disaster Management Policy to establishing a Contingency Planning framework (Government of Bangladesh, 2008).
- Moreover, earthquake contingency planning and capacity building are highly emphasized at Standing Orders on Disaster (SOD) of Bangladesh (Government of Bangladesh,2019).
- According to "National Plan for Disaster Management (2010-2015)" of Bangladesh, the pre-disaster, response and post-disaster activities involve overall command and co-ordination, search, rescue and evacuation, health, relief services and shelter, water supply, sanitation and hygiene, restoration of urban services, transport and security and welfare.

Contingency plan can bring them under one umbrella

Hierarchy of Contingency Planning

National Level

- National contingency plan generally addresses **more than one disasters including all potential hazards**.
- **Evaluation of the capacity of national set-up** and description of the approach to be taken for emergency response nationally are focused here.
- **Institutional role of different departments and co-ordination strategy** to respond are also included in this plan.

Regional Level

- The plan area is **demarcated based on the needs, type and geographical context**
- It could be prepared for a number of regions.
- Necessary requirements to respond, working relationships, **roles and procedures to coordinate among the areas**, and identification of event triggers are mainly focused here.

 (International Federation of Red Cross and Red Crescent Societies, 2012)

Hierarchy of Contingency Planning

Regional Level

- The plan area is demarcated based on the needs, type and geographical context
- It could be prepared for a number of countries or for regions where there are cross border issues to consider.
- Necessary requirements to respond, working relationships, roles and procedures to coordinate among the areas, and identification of event triggers are mainly focused here

Community Level

- Local community can provide great deal of information regarding their own risks and capacities; these are brought under consideration in community level contingency plan.
- **Components of plan and institutional set up** are decided based on community consultation and local context.

(International Federation of Red Cross and Red Crescent Societies, 2012)

Demarcation of Contingency Plan Area

- For micro level planning and management, **delineation of contingency plan boundary is necessary.**
- **No hard and fast standard rule** for demarcation.
- Since this plan is prepared for emergency community response, geographical coverage of the plan could be delineated through **community consultation**.

Demarcation of Contingency Plan Area

- The Planning Area can be divided into number of clusters based on **geographical coverage, population distribution, existence of natural boundaries or following the cluster units developed at any previous development works** of the community.

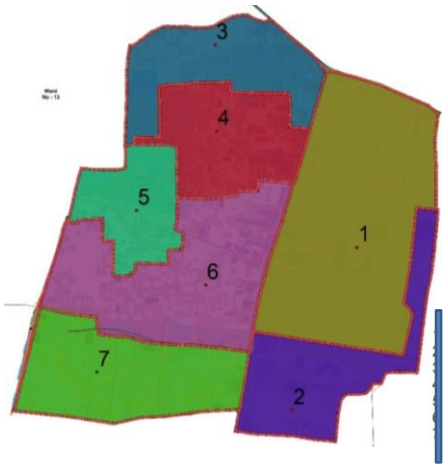


Figure 1: Demarcation of plan area

Hardware and Software Requirement for Contingency Planning

- For data collection, storage, management and analysis, **computer, tab or mobile phone and different computer based software** can be used.
- For field level data collection, **digital or paper based questionnaire or checklist** can be used and **digital satellite image** can be use for the management of geographical mapping.
- For the collection of physical and social vulnerability data digitally, "**KoBoToolbox**" can be used as it helps to maintain the data authenticity and real-time data collection.
- For the data analysis and mapping of contingency planning, several statistical analysis software and geo-statistical analysis software can be used.

Data Requirement for Contingency Planning

Information Type	Required Data
Socio-Economic Information	• Demographic data of the households (Age, Gender, Education level, Family size, Disable persons in the families, Household income, Property ownership) • Awareness level of the community • Knowledge and perception about earthquake
Structural Information	• Structure type and shape of the building • Floor area of the building • Building storey, set back, overhang • Seismic force resisting system • Structural materials of the buildings
Seismic Information	• Soil type • Soil quality • Geological composition
Land Use Information	• Building use • Availability of public buildings, healthcare facilities and open spaces • Capacity and structural condition of public buildings • Road width and road condition

(BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Tools for Collecting the data

- Microtremor test for geological data is required for assessing the seismic exposure.
- Rapid Visual Screening (RVS) in prescribed questionnaire format can be used to assess the physical vulnerability of structures.
- For social vulnerability assessment, questionnaire survey is required.
- To understand about community awareness and institutional set up, “Participatory Approach” (i.e. Focus Group Discussion, KII) can be used.

Scenario Development for Contingency Planning

- Contingency plan of an area can be changed with different scenarios.
- The scenarios can be developed based on:
  - ✓ The magnitude of the earthquake
  - ✓ Structural vulnerability of the area
  - ✓ The result of Rapid Visual Screening (RVS)
  - ✓ Time of the earthquake
  - ✓ Land use of the area
  - ✓ Season/ weather condition during earthquake
  - ✓ Social cohesion within the community

Components of Contingency Planning at Community Level

- Community level contingency planning in Bangladesh mainly includes five components:
  - ➢ Ward Co-ordination Center planning at Ward level considering community-based disaster risk management
  - ➢ Evacuation Route Planning
  - ➢ Temporary Shelter Planning
  - ➢ Emergency Health Facility Planning
  - ➢ Household level preparedness planning

(BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Ward Co-ordination Center

- One of the first tasks during and after any disaster is to coordinate the different activities of management.
- Ward Co-ordination Center is required during earthquake in order to
  - ✓ Ensure proper mobilization and management of personnel and necessary equipment.
  - ✓ Supplies the facilities immediately after an earthquake.
- The location and management system of the co-ordination center needs to be decided based on community consultation.

Selection Criteria for Ward Co-ordination Center

- In identifying Ward Co-ordination Center following assumptions are considered:
  - ✓ The facility should be in a public building
  - ✓ Should be structurally safe (based on RVS score)
  - ✓ Ideally should be centrally located and
  - ✓ Easily accessible

Evacuation Route Planning

- Evacuation route is the **route designated to move to a safer place** and **to ensure connection with different facilities** in an emergency situation, such as a fire or earthquake (CollinsDictionary.com, 2018).
- It is influenced by the **condition of the infrastructure** of the affected area to ensure the accessibility to the safer place.
- Evacuation route planning involves following steps:
    1. Identifying vulnerable building
    2. Determining blockage on the roads
    3. Determining the accessibility of open roads
    4. Identifying evacuation route

Method for developing evacuation route

1. **Identifying vulnerable buildings**
    - Structurally unsafe buildings are identified according to **RVS score**
    - Buildings which have a RVS value equal of **less than a specified RVS cut-off score** (decided by a civil engineer with background in geo-technical engineering based on the geological context of the area) is considered as vulnerable

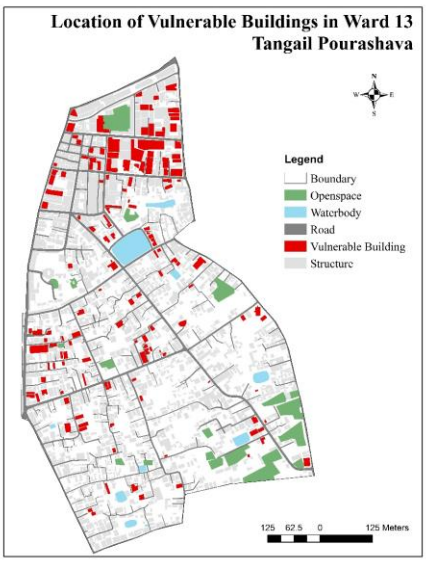


Figure 2: Identification of vulnerable buildings

Method for developing evacuation route

2. Determining blockage on the roads

- Debris from the collapsed building is expected to partially or fully block road
- **Building height, setback and front road width** determine the type of blockage
- Three types of blockage are considered: No block condition; Partial block condition; Full block condition.

Method for developing evacuation route

2. Determining blockage on the roads

- **<u>No block condition:</u>**

Vulnerable URM building below three stories: if collapse **would be on the site**.

Vulnerable RCC building below three stories: if collapse **would not block the road.**

No block condition: URM and RCC buildings below three storied

Figure 3: Collapsed URM buildings

Figure 4: Collapsed RCC buildings

Method for developing evacuation route

2. Determining blockage on the roads

Partial blockage:

Vulnerable URM building three storied or more: If the building height is at least one foot less than the sum of width of front road and set back, then **the road would be partially blocked**.

Figure 5: Partial blockage by URM buildings

Partial block condition:

(The front road width + setback space) – Building height ≥ 0.305 metre

Method for developing evacuation route

2. Determining blockage on the roads

Partial blockage:

Vulnerable RCC building three storied or more:

- If the building height is at least one foot less than the sum of width of front road and set back, then it was considered that **the road would be partially blocked.**

Figure 6: Partial blockage by RCC buildings

Partial block condition:

(The front road width + setback space) – Building height ≥ 0.305 metre

Method for developing evacuation route

2. Determining blockage on the roads

Partial blockage:

Vulnerable RCC building three storied or more:

- If the building height is greater than the sum of width of front road and safe building with more than one storey on the opposite side of the road, then the building will have stuck on the opposite building **leaving some space for movement of people underneath**

Figure 7: Partial blockage by RCC buildings according to second condition

Method for developing evacuation route

2. Determining blockage on the roads

Full blockage:

Vulnerable URM building three storied or more: If the building height is greater than or equal to the sum of width of front road, then it **will fully block the road in front of it.**

Figure 8: Full blockage by URM buildings

Full block condition:

(The front road width + setback space) – Building height ≤ 0.305 metre

Method for developing evacuation route

2. Determining blockage on the roads

Full blockage:

Vulnerable RCC building three storied or more: If the building height is greater than or equal to the sum of width of front road and there is either no building or semi pucca or one storied or multi storied vulnerable building on the opposite side of the road, then **it will fully block the road in front of it.**

Figure 9: Full blockage by RCC buildings

Full block condition:

(The front road width + setback space) – Building height ≤ 0.305 metre

Method for developing evacuation route

3. Determining the accessibility of open roads

- After determining the blockage of roads, the open roads are identified and categorized them based on following categories:
  - Routes, where the only pedestrian could move i.e. **road width, is equal or less than 0.7 metre**
  - Routes, where pedestrian, bicycle, motorcycle or non-motorized traffic (rickshaw or van) could move one way i.e. **road width, is 0.7 to 1.83 metre**
  - Routes, where two-way non-motorized traffic (rickshaw or van) or one-way motorized traffic could move i.e. **road width, is 1.83 metre to 3.7 metre**
  - Routes which can be used by two-way motorized vehicle i.e. **road width more than 3.7 metre**

Method for developing evacuation route

4. Identifying evacuation route

- The route is designed to reach the safe places as quick as possible during earthquake.
- Considering the width of open roads and the location of potential temporary shelters, open spaces and emergency healthcare facilities, the network database is developed within the GIS software environment.
- Then the evacuation route is found using the "**shortest path method**" through network analysis.

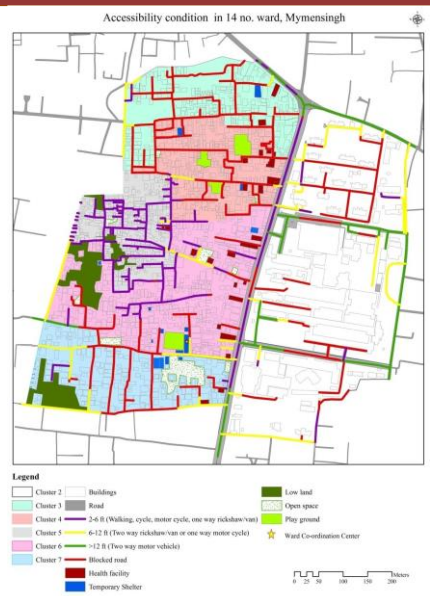


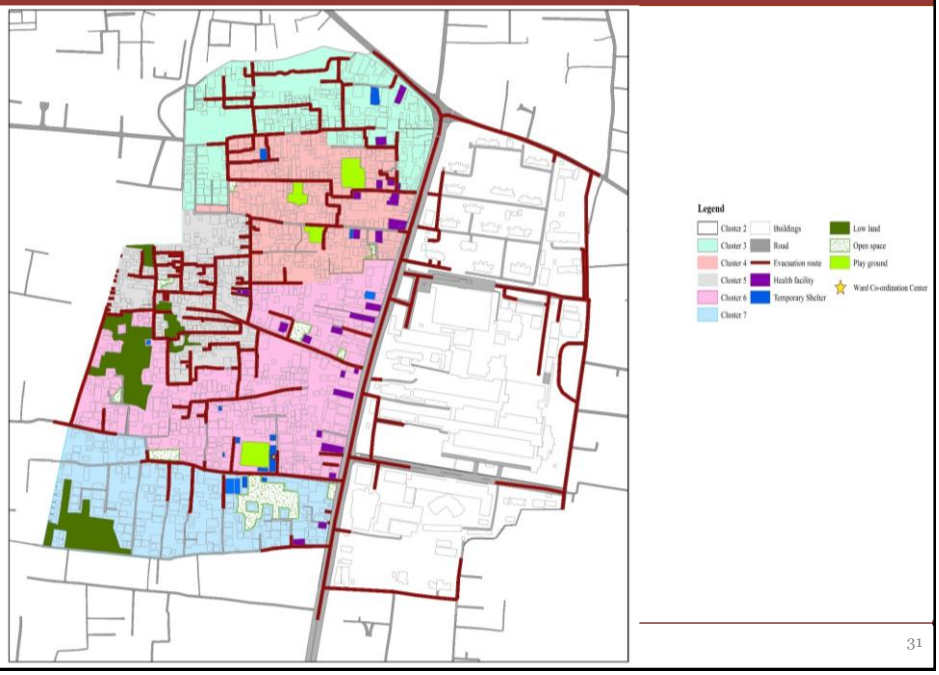
Figure 10: Identifying evacuation route

Method for developing evacuation route

4. Identifying evacuation route

- Based on road blockage and accessibility, the evacuation route map was prepared and finalized.
- This route will be usable for the evacuees to move to the temporary shelters, to take the injured people to the emergency health facilities and to connect the temporary shelters and the emergency health facilities with the Ward Co-ordination Center.

Evacuation Route (an example)



Temporary Shelter Planning

Figure: Effect of earthquake and aftershock in Nepal earthquake, 2015
(Source: The observer, 2015, The Conversation, 2015)

Temporary Shelter Planning

- Provides protection and a habitable environment to the affected population while the **outcomes of a disaster are being evaluated and then rectified**
- Crucial for **recovery and reconstruction** in the post-disaster phase

Figure: Temporary shelter at public buildings in Japan

Figure: Temporary shelter at open space in Nepal

(Source: BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Temporary Shelter Planning

For further understanding about importance of temporary shelter planning watch:

https://www.youtube.com/watch?v=mdnoxHLYhak

Temporary Shelter Planning: Steps

- Temporary shelter planning includes three steps:
  - ✓ **Need assessment**
  - ✓ **Space availability assessment**
  - ✓ **Need-availability comparison**
  - ✓ **Estimation of amenities requirement in temporary shelter**

Temporary Shelter Planning: Need assessment

- **Scenario 1: All the people in living in a community would require shelter**
- **Scenario 2: People living in collapsed or damaged building would require shelter**
  - Identification of the vulnerable residential and mixed used buildings in the study area (having RVS score equal or less than pre-determined cut-off value)
  - Estimation of number of people living in the identified vulnerable buildings
  - About 50% of these total affected population would take shelter in their neighbors', relatives' and friends' houses.

Total population requiring temporary shelter =

Total number of people living in the vulnerable residential and mixed used buildings * 50%

Temporary Shelter Planning: Space availability assessment

- **Potential facilities** to be considered for shelter (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012).
  - Large-park, playground and open space, and
  - Institutional buildings: public, religious, educational, community, etc.

- **Assumptions for identification of potential temporary shelter:**
  - Should be acceptable by local people
  - Should be structurally safe
  - Should be accessible

Temporary Shelter Planning: Space availability assessment

Preference of the community

ক্রম	প্রকার	কারন উল্লেখ করুন	
		পছন্দ করার কারন	পছন্দ না করার কারন
	খোলা জায়গা (তাঁবু)		
	খেলার মাঠ (তাঁবু)		
	শিক্ষা প্রতিষ্ঠান		
	ধর্মীয় প্রতিষ্ঠান		
	সরকারি প্রতিষ্ঠান		

Temporary Shelter Planning: Space availability assessment

- **Identification of potential temporary shelter**
  - acceptable by local people (preferred uses)
  - structurally safe (based on RVS score)
  - accessible (considering evacuation route)
- **Final verification** through **community consultation**

Temporary Shelter Planning: Space availability assessment

- **Capacity estimation of the selected temporary shelter:**
  - Of total area of the identified temporary shelter (total area for open space and total floor area for buildings)
    - About 20% would be used for amenities like toilet, circulation etc.
    - About 80% would be available for shelter.
  - A person would need 1.8 square meter space in the temporary shelter (Sphere Project, 2011 & Xu, Okada, Hatayama, & He, 2006).

$$\textbf{\textit{Population can be accomodated in a shelter}} = \frac{\textbf{\textit{Available Space for Temporary Shelter}} X 0.8}{1.8}$$

Temporary Shelter Planning: Need-Availability comparison

- **Compare need and availability to understand**
  - **Surplus:** To accommodate people from surrounding areas
  - **Deficit:** To arrange for additional temporary shelter

Temporary Shelter Planning: Amenity requirement

Table: Standard for amenities requirement estimation at temporary shelter

	Facility/ Amenity	Standard
	Toilet	1 per 50 persons
	Water	0.015 cubic-meter per person per day
	People requiring first aid treatment	50% of people in temporary shelter
	Volunteer with first aid treatment training	1 per 72 injured people
	First aid box	1 per 10 injured people

(Source: Sphere Project, 2011)

Temporary Shelter Planning: An Experience from Mymensingh

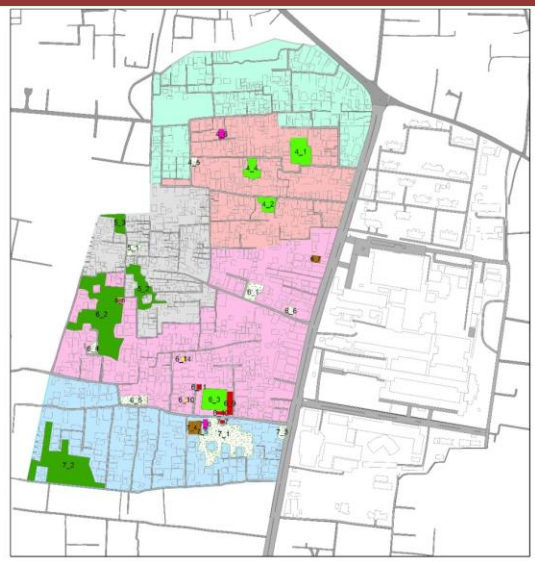


Figure: Temporary shelter in Ward no. 14, Mymensingh Municipality

(Source: BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Temporary Shelter Planning: An Experience from Mymensingh

Wet season **Dry season**

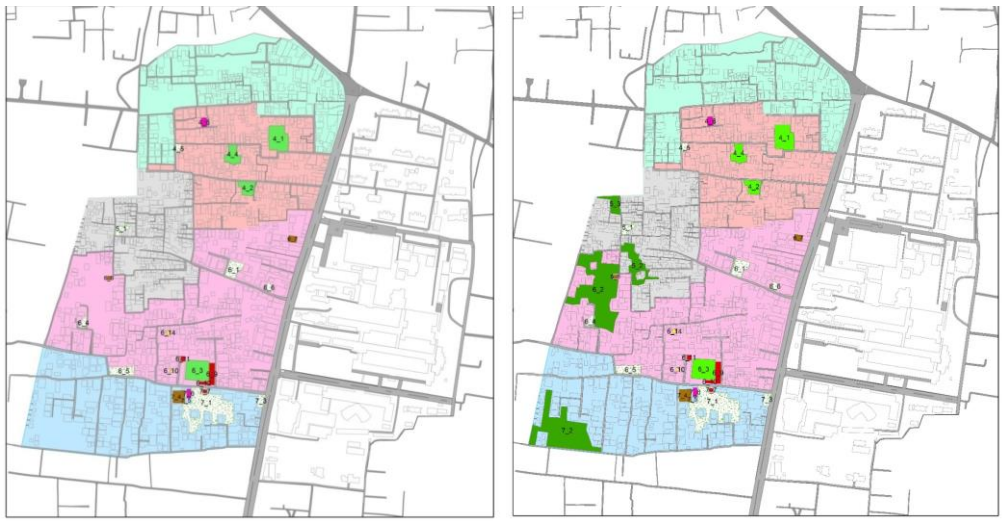


Figure: Temporary shelter in Ward no. 14, Mymensingh Municipality

(Source: BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Temporary Shelter Planning: An Experience from Mymensingh

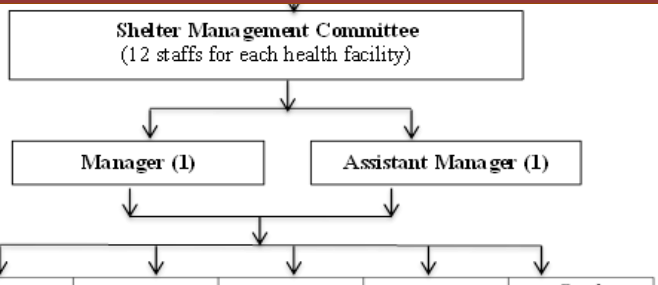
Cluster	Demand		Space availability	Surplus/ Deficit in dry season			Surplus/ Deficit in wet season	
	Demand Scenario 1	Demand Scenario 2		Demand Scenario 1	Demand Scenario 2		Demand Scenario 1	Demand Scenario 2
3	2,071	392	-	**-2,071**	**-392**	-	**-2,071**	**-392**
4	1,996	468	1,449	**-657**	**871**	1,339	**-657**	**871**
5	1,466	185	1,063	**-403**	**878**	113	**-1,353**	**-72**
6	3,502	792	4,377	**845**	**3555**	1,627	**-1,875**	**835**
7	2,308	437	4,388	**2,081**	**3952**	2,130	**-178**	**1693**
Total	11,343	2,273	11,277	**-205**	**8865**	5,209	**-6,134**	**2,936**

In dry season
Scenario 1 : there is **Deficit of space in 3,4,5**
Scenario 2 : **Deficit of space in cluster 3.**

In wet season
Scenario 1 : there is **Deficit of space in all clusters**
Scenario 2 : **Deficit of space in cluster 3 and 5.**

(BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Temporary Shelter Planning: Management



Phase	Registration and Information team (2 team leader)	Relief team (2 team leader)	First aid team (2 team leader)	Building maintenance and sanitation team (2 team leader)	Food preparation and management team (2 team leader)
Activities before event	Organizing training and drill Participatory vulnerability assessment Resource organization Prepare for respective jobs				
Activities during and after event	Register the people entering, collection of information, etc.	Relief requirement and management, emergency supplies management etc.	First aid of injured people, etc.	Ensure maintenance and sanitation, etc.	Meals preparation/ distribution, water supply/ distribution,, etc.

Temporary Shelter Planning: Management

For further understanding please watch:

Disaster shelter management

https://www.youtube.com/watch?v=iMm9NxKgU6c

Children in disaster shelter

https://www.youtube.com/watch?v=3JE-L9MLW24

Emergency Health Facility Planning

Figure: Effect of earthquake and aftershock in Nepal earthquake, 2015
(Source: The observer, 2015, The Conversation, 2015)

Emergency Health Facility Planning

- Necessary to immediately minimize the sufferings of the injured people after an earthquake

Figure: Rapid management of Rana Plaza victims in Enam Medical College Hospital

Figure: Temporary shelter at open space in Nepal

(Source: Enam Medical College & Hospital, 2017; Elsharkawi et al., 2010)

Emergency Health Facility Planning: Steps

- Emergency health facility planning includes three steps:
  - ✓ **Need assessment**
  - ✓ **Space availability assessment**
  - ✓ **Need-availability comparison**
  - ✓ **Estimation of amenities requirement in emergency health facility**

Emergency Health Facility Planning: Need assessment

Table: Different severity levels of injury and treatment requirement

Injury	Treatment requirement	Treatment provision
Severity 1	First aid, e.g. bandages or observation. Example: Sprain, severe cut, minor burn, bump on the head without loss of consciousness, etc.	First aid (At temporary shelters and local pharmacies)
Severity 2	A greater degree of medical care and use of medical technology such as x-rays or surgery, but not expected to progress to a life-threatening status. Example: Second or third-degree burn over large parts of the body, a bump on the head causing loss of consciousness, fractured bone, dehydration etc.	Treatment at local health facility
Severity 3	Pose an immediately life-threatening condition if not treated adequately and expeditiously. Example: Uncontrolled bleeding, punctured organ, another internal injury, spinal column injury, crush syndrome etc.	
Severity 4	Instantaneously killed or mortally injured	Minimum treatment at local health facility and then transfer to regional facility for specialized treatment

Emergency Health Facility Planning: Space availability assessment

- **Facilities** to be considered for emergency health facility
  - hospitals, clinics, and diagnostic centers
- **Assumptions for identification of emergency health facility:**
  - Should be acceptable by local people
  - Should be structurally safe
  - Should be accessible

Emergency Health Facility Planning: Space availability assessment

- **Identification of emergency health facility**
  - Structurally safe (based on RVS score)
  - Accessible (considering evacuation route)
  - Acceptable by local people: Final verification through **community consultation**

Emergency Health Facility Planning : Space availability assessment

- **Capacity estimation of the selected emergency health facilities:**
  - Of total floor area of the identified emergency health facilities
    - About 20% would be used for amenities like toilet, circulation etc.
    - About 80% would be usable for treatment.
  - About 50% of the usable space (within above mentioned 80% floor area) would be occupied by patients who were admitted to the facility before the earthquake.
  - A person would need 2 square meter space in an emergency health facility (Sphere Project, 2011 & Xu, Okada, Hatayama, & He, 2006).

Emergency Health Facility Planning: Need-Availability comparison

- **Compare need and availability to understand**
  - **Surplus:** To accommodate people from surrounding areas
  - **Deficit:** To arrange for additional emergency healthcare facility

Emergency Health Facility Planning: Amenity requirement

- All healthcare facilities need to serve more than their capacities after earthquake.
- Additional doctors, nurses, beds and other supporting facilities may require after earthquake.

Table: Standard for amenities requirement estimation at emergency health facility

	Facility/ Amenity	Standard
	Toilet	1 per 20 persons
	Water	0.05 cubic-meter per person per day
	No. of doctors	1 for 20 patient
	No. of nurses	4 nurses with each doctor

(Source: Sphere Project, 2011)

Emergency Health Facility Planning: An Experience from Mymensingh

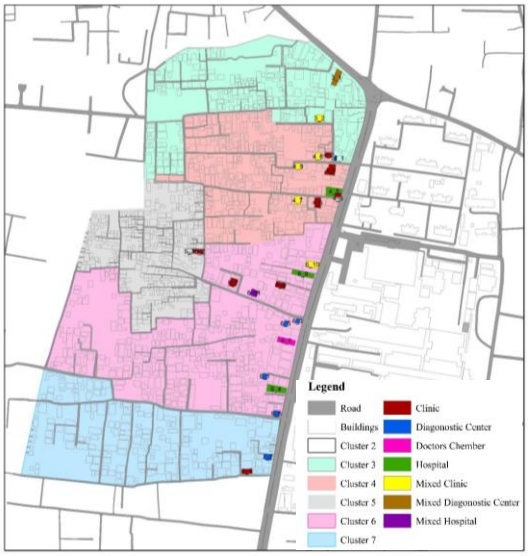


Figure: Emergency health facilities in Ward no. 14, Mymensingh Municipality

(Source: BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

Emergency Health Facility Planning: Management

Health facility Management Committee
(12 staffs for each health facility)

Manager (1) | **Assistant Manager (1)**

Phase	Registration and Information team (2 team leader)	Relief team (2 team leader)	Treatment team (2 team leader)	Building maintenance and sanitation team (2 team leader)	Food preparation and management team (2 team leader)
Activities before event	Organizing training and drill Resource organization Prepare for respective jobs				
Activities during and after event	Register the injured people entering, collection of information, etc.	Relief requirement and management, emergency supplies management etc.	Guide treatment of injured people, etc.	Ensure maintenance and sanitation, etc.	Meals preparation/ distribution, water supply/ distribution,, etc.

Institutional Setup and Management Activities

- Implementation of the contingency plan and disaster management at the event of an emergency
- **At Ward level:**
  - As per SOD: Ward Disaster Management Committee (WDMC)
  - To connect the Ward with Municipality/City corporation level
- **At community level:**
  - Ward Coordination Center (WCC):
  - To maintain the co-ordination among the community level committees and with WDMC

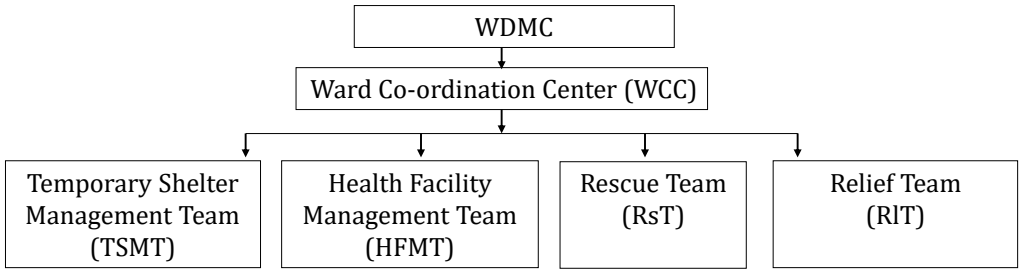
Institutional Setup and Management Activities: Ward Co-ordination Center (WCC)

- To ensure proper **mobilization and management** of personnel and necessary equipment
- **Selection criteria:**
  - Acceptable by local people
  - Local government facility
  - Structural safety
  - Central location and accessibility

For further understanding please watch:

https://www.youtube.com/watch?v=RwtEp84tGYQ

Institutional Setup and Management Activities: Ward Co-ordination Center (WCC)





Institutional Setup and Management Activities: CBDM

- Community Based Disaster Management (CBDM)
  - Local people are the direct sufferer and are first responders
  - Local people possess greater knowledge about the community
  - Local people have greater bond among each other
  - For capacity building of the community
  - For bottom-up approach



Institutional Setup and Management Activities: CBDM

- Capacity building as per responsibility

For further understanding about importance of capacity building for disaster management, please watch:

https://www.youtube.com/watch?v=Mxp6R1D2Kng

https://www.youtube.com/watch?v=9AqXUyZjo2o

৫.৩) আপনি কি ভুমিকম্পের পর স্বেচ্ছাসেবক হিসেবে কাজ করতে ইচ্ছুক?

☐ হ্যাঁ

☐ না

যদি হ্যাঁ হয় তবে সেচ্ছাসেবক হিসেবে আপনি কোন কাজে নিয়োজিত হতে চান ক্রম অনুসারে উল্লেখ করুন

ক্রম	দায়িত্ব
	উদ্ধার কার্য
	প্রাথমিক চিকিৎসা
	মানসিক পরিচর্যা
	আশ্রয়কেন্দ্র ব্যবস্থাপনা
	খাদ্য প্রস্তুতি
	যোগাযোগ স্থাপন

আপনার সাথে যোগাযোগের ফোন নং-

Contingency planning: Sharing and vetting by the Community

- Focus group discussion
- For further validation, confirmation and final decision with and by the local people

Figure: Community sharing in Mymensingh

Finalization of Contingency Plan

According to the suggestions of community people

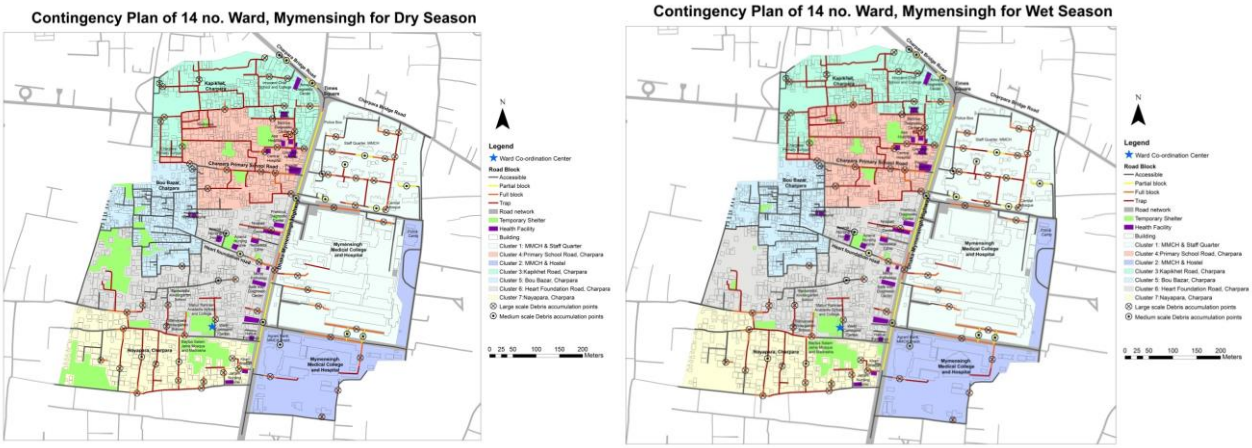


Figure: Final Contingency Plan of Ward 14, Mymensingh Municipality

(Source: BUET-Japan Institute of Disaster Prevention and Urban Safety (BUET-JIDPUS) & Department of Urban and Regional Planning, 2018)

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Thank You

APPENDIX-II

Participants List of Rangpur City Corporation

Sl No.	Name	Designation	Institution
1.	Md. Ruhul Amin Mia	Chief Executive Officer	Rangpur City Corporation
2.	Md. Emdad Hossain	Engineer	Rangpur City Corporation
3.	Md. Azam Ali	Executive Engineer	Rangpur City Corporation
4.	Md. Abu Jafar	Assistant Engineer	Rangpur City Corporation
5.	Md. Asaduzzaman Choudhury	Assistant Engineer	Rangpur City Corporation
6.	Radib Al Amin	Assistant Engineer	Rangpur City Corporation
7.	Anup Kumar Bishwas	Assistant Engineer	Rangpur City Corporation
8.	Sukumar Sarkar	Assistant Engineer	Rangpur City Corporation
9.	Md. Nazrul Islam	Urban Planner	Rangpur City Corporation
10.	Abdullah al Baki	Sub-Assistant Engineer	Rangpur City Corporation
11.	Mustafizur Rahman	Sub-Assistant Engineer	Rangpur City Corporation
12.	Md. Enamul	Sub-Assistant Engineer	Rangpur City Corporation
13.	Md. Akiruzzama	Sub-Assistant Engineer	Rangpur City Corporation
14.	Mushfique Ahammed	Contractor	Hometech Consultant Ltd.
15.	Bulbul Ahammed	Contractor	
16.	Md. Fasir Uddin Sarder	Officer	Fire Service & Civil Defense, Rangpur
17.	Md. Mudabbir Hossain	Officer	Fire Service & Civil Defense, Rangpur
18.	Jahangir Alam Sarker	Officer	Fire Service & Civil Defense, Rangpur

19.	Khan Abdul Motaleb	UNDP representative	UNDP
20.	Sajjad Haider	Volunteer	UCV, Rangpur
21.	Khurshida Jahan	Volunteer	UCV, Rangpur
22.	Sheuli Akter Shoma	Volunteer	UCV, Rangpur
23.	Shammi Akter	Volunteer	UCV, Rangpur

Participants List of Tangail Paurashava

Sl. No.	Name	Designation	Institution
1.	Md. Shahidul Islam	Town Planner	Tangail Paurashava
2.	Md. Monzur Hossain	Assistant Engineer	Mirzapur Paurashava
3.	Khandakar Sayeed Al Khalid	Structural Engineer	
4.	Mir Mohammad Chunnu	Assistant Engineer	Education Engineering Dept.
5.	Md. Yousuf	Assistant Engineer	ADCL, Tangail
6.	Md. Jabedul Islam	Assistant Engineer	Tangail Paurashava
7.	AKM Jinnatul Haque Mukta	Sub-Assistant Engineer	Tangail Paurashava
8.	Bishnu Pada Sharker	Administrative Officer	Tangail Paurashava
9.	Md. Mizanur Rahaman	Assistant Engineer	Tangail Paurashava
10.	Sibbir Ahmed Azmir	Executive Engineer (In charge),	Tangail Paurashava
11.	Md. Monir Hossain	Senior Architect	
12.	Md. Liton Ahmed	Junior Architect	
13.	Md. Tareq Poton	Contractor	MS Nakshi Enterprise
14.	Joynal Abedin	Contractor	MS Dola Enterprise
15.	Engr. Abdul Awal Khan	Contractor	MS ZF Enterprise
16.	Selim Reza	Contractor	MS SR Enterprise
17.	Md. Al-Amin Bhuiya	Volunteer	UCV, Tangail

18.	Akanda Fuad Been Hasan	Construction Engg.	UCV, Tangail
19.	Tawhid Khan	Volunteer	UCV, Tangail
20.	Sabbir Hossain	Volunteer	UCV, Tangail

Participants List of Sunamganj Paurashava

Sl. No.	Name	Designation	Institution
1.	Nader Bakth	Mayor	Sunamganj Pourashava
2.	Md. Ishaque Bhuiyan	Secretary	Sunamganj Pourashava
3.	Mir Musharraf Hussain	Executive Engineer	Sunamganj Pourashava
4.	Kali Krishna Pal	Assistant Engineer	Sunamganj Pourashava
5.	Ashraful Islam (Kayes)	Sub Assistant Engineer	Sunamganj Pourashava
6.	Asaduzzaman	Construction Inspector	Sunamganj Pourashava
7.	Md. Mobassir Billah	Architect	
8.	S. M. Mashudul Islam	Architect	
9.	Mohammed Maksudur Rahman	Planner	
10.	Adri Roy	Diploma Engineer (Civil)	
11.	Hussain Ahmed (Anis)	Diploma Engineer (Civil)	
12.	Aresh Chandra Dey	Diploma Engineer (Civil)	
13.	Md. Atikur Rahman	Contractor	
14.	Babul Kanti Dey	Contractor	
15.	Liton Sarker	Contractor	
16.	Imtiaz Alam	Contractor	
17.	Md. Shafiqul Islam	Contractor	
18.	Shafiqul Islam	Officer	Fire Service & Civil Defense, Sunamganj

19.	Newton Das Talukdar	Officer	Fire Service & Civil Defense, Sunamganj
20.	Md. Sadrul Islam Sourov	Volunteer	UCV
21.	Ridoy Chando	Volunteer	UCV
22.	Saleha Begum	Volunteer	UCV
23.	Ifran Ali Shahi	Volunteer	UCV
24.	Ripan Sarker	Volunteer	UCV
25.	Tanni Begum	Volunteer	UCV
26.	Purnima Sarkar Bappy	Volunteer	UCV
27.	Md. Nizam Uddin	Project Co Focal	Sunamganj District Office

Participants List of Rangamati Paurashava

Sl No.	Name	Profession	Instituition
1.	Md. Atikur Rahman	Executive Engineer	Rangamati Paurashava
2.	Md. Wasim Akram	Assistant Engineer	Rangamati Paurashava
3.	Flora Barua	Engineer	
4.	Arnab Chakma	Civil Engineer	
5.	Puspa Dhana Chakma	Civil Engineer	
6.	Binoy Chakma	Civil Engineer	
7.	Jiten Chakma	Civil Engineer	
8.	Milan Chakma	Architect	
9.	Jimi Chakma	Architect	
10.	Kanny Chakma	Architect	
11.	Sujoy Talukder	Architect	
12.	Md. Anowar Hossain Khokon	Contractor	
13.	Md. Kamal Hossain	Contractor	
14.	Md. Selim Khan	Contractor	
15.	Mina Chakma	Volunteer	
16.	Md. Faizul Islam	Volunteer	

17.	Md. Didar Gani	Volunteer	
18.	Mital Chakma	Urban Planner	
19.	Suvarna Chakma	Town Planner	Rangamati Paurashava

APPENDIX-III

ন্যাশনাল রেজিলিয়েন্স প্রোগ্রামঃ ডিডিএম পার্ট

ভূমিকম্প বিষয়ক প্রশিক্ষকদের প্রশিক্ষণ (ট্রেইনিং অব ট্রেইনার্স)

পূর্ব – প্রশিক্ষণ প্রশ্নাবলী

নিম্নের প্রশ্নগুলোর সঠিক উত্তরে টিকচিহ্ন (√) দিন।

১) আপদ (Hazard) ও দুর্যোগ (Disaster) এর মধ্যে মূল পার্থক্য কি?

(ক) আপদ মানবসৃষ্ট কিন্তু দুর্যোগ প্রাকৃতিক ঘটনা

(খ) আপদ দুর্যোগ নয় বরং দুর্যোগের সম্ভাব্য কারণ

(গ) কোন পার্থক্য নেই

২) নিচের কোনটি দুর্যোগের (Disaster) উদাহরণ নয়?

(ক) একটি জনমানবশূন্য এলাকায় ভূমিকম্পের কম্পন অনুভূত হয়েছে কিন্তু কোন ক্ষয়ক্ষতি হয়নি

(খ) একটি শহরে ভূমিকম্পের কারণে কয়েকটি ভবন ধসে পরেছে

(গ) ভূমিকম্পের কারণে একটি পারমাণবিক বিদ্যুৎকেন্দ্রে বিস্ফোরণ হয়েছে

৩) বিপদাপন্নতা (Vulnerability) সম্পর্কে কোনটি সত্য?

(ক) একটি এলাকায় প্রাকৃতিক দুর্যোগের ফলে সংঘটিত ক্ষয়ক্ষতির সম্ভাব্যতা

(খ) সামাজিক, ভৌগলিক, কাঠামোগত ইত্যাদি কারণে প্রাকৃতিক বা মানবসৃষ্ট আপদে আক্রান্ত হওয়ার সম্ভাবনা

(গ) একটি সমাজ ভূমিকম্পের সম্ভাব্য বিপদ সম্পর্কে কতটুকু সচেতন তার মাত্রা

৪) নিচের কোনটি ভূমিকম্পের সক্ষমতার (Capacity) উদাহরণ নয়?

(ক) কোন ব্যক্তির কাঠামোগতভাবে দুর্বল ভবনকে শক্ত করে দেওয়া

(খ) ভূমিকম্প সাড়াদানের জন্য এলাকায় প্রশিক্ষণপ্রাপ্ত স্বেচ্ছাসেবক দল তৈরি করা

(গ) কোন আর্থিকভাবে অসচ্ছল ব্যক্তির টিনের আধাপাকা ঘরকে পাকা ঘরে রুপান্তরিত করে দেওয়া

৫) নিচের কোনটি ভূমিকম্প ঝুঁকির (Risk) উদাহরণ নয়?

(ক) ভবনের দুর্বল কাঠামো

(খ) বাসার আশেপাশে খোলা জায়গা থাকা

(গ) ভূমিকম্প সম্পর্কে সচেতনতার অভাব

৬) ভূমিকম্পের কেন্দ্র (Hypocenter) কোনটি?

(ক) ভূপৃষ্ঠের উপরস্থ যেই বিন্দু থেকে ভূমিকম্পের সূচনা হয়

(খ) ভূপৃষ্ঠের উপরস্থ যেই বিন্দুতে প্রথম ভূমিকম্পের কম্পন অনুভূত হয়

(গ) ভূগর্ভস্থ যে স্থান হতে ভূমিকম্পের উৎপত্তি হয়

৭) বাংলাদেশের ভৌগলিক অবস্থানের ক্ষেত্রে কোনটি সত্য নয়?

(ক) ভূমিকম্প প্রবণ ইউরেশিয়া প্লেট, ইন্ডিয়ান প্লেট ও মায়ানমার সাবপ্লেটের মাঝখানে বাংলাদেশ অবস্থিত।

(খ) বাংলাদেশ ও আশেপাশে অবস্থিত টেকটোনিক প্লেটগুলো স্থিতিশীল অবস্থায় আছে

(গ) বাংলাদেশের ও মায়ানমারের মধ্যকার দূরত্ব ক্রমশই প্রতি বছর কমে আসছে

৮) কোনটি ভূমিকম্পের প্রাথমিক প্রভাব (Primary effect)?

(ক) সুনামি

(খ) অগ্নিকান্ড

(গ) ভূমির তরলীকরণ

৯) ভূকম্পন তরঙ্গ (Seismic wave) মূলত কত প্রকার?

(ক) ২

(খ) ৩

(গ) ৪

১০) ভূমিকম্পের মাত্রা (Magnitude) ও তীব্রতা (Intensity) সম্পর্কে কোনটি সত্য?

ক) একই ভূমিকম্পের মাত্রা সমান কিন্তু বিভিন্ন স্থানে বিভিন্ন তীব্রতা হতে পারে

খ) ভূমিকম্পের তীব্রতা পরিমাপ করা হয় সিসমোগ্রাফ যন্ত্রের মাধ্যমে

গ) ভূমিকম্পের মাত্রা পরিমাপ করতে ৩ ধরনের স্কেল ব্যবহৃত হয়

১১) নিচের কোন কাজটি দুর্যোগ প্রস্তুতির (Disaster preparedness) অংশ নয়?

ক) ঘরে খাদ্য ও জরুরি পণ্য মজুদ রাখা

খ) ভূমিকম্প হলে কি করতে হবে সে সম্পর্কে জ্ঞান অর্জন করা

গ) নিরাপদ ও ভূমিকম্প-সহনশীল ভবন নির্মাণ করা

১২) নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ বিভিন্ন ধাপের কাজগুলো পর্যায়ক্রমে/ ধারাবাহিকভাবে সংঘটিত হয়?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

১৩) নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ বিভিন্ন ধাপের কাজগুলো সমান্তরালে চলে?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

১৪) নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ আর্থ-সামাজিক অবস্থার কথা বিবেচনা করা হয়?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

১৫) দুর্যোগের মূল কারণ (Root cause) সম্পর্কে নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ আলোচনা করা হয়েছে?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

ন্যাশনাল রেজিলিয়েন্স প্রোগ্রামঃ ডিডিএম পার্ট

ভূমিকম্প বিষয়ক প্রশিক্ষকদের প্রশিক্ষণ (ট্রেইনিং অব ট্রেইনার্স)

প্রশিক্ষণ- পরবর্তী প্রশ্নাবলী

নিম্নের প্রশ্নগুলোর সঠিক উত্তরে টিকচিহ্ন (√) দিন।

১) আপদ (Hazard) ও দুর্যোগ (Disaster) এর মধ্যে মূল পার্থক্য কি?

(ক) আপদ মানবসৃষ্ট কিন্তু দুর্যোগ প্রাকৃতিক ঘটনা

(খ) আপদ দুর্যোগ নয় বরং দুর্যোগের সম্ভাব্য কারণ

(গ) কোন পার্থক্য নেই

২) নিচের কোনটি দুর্যোগের (Disaster) উদাহরণ নয়?

(ক) একটি জনমানবশূন্য এলাকায় ভূমিকম্পের কম্পন অনুভূত হয়েছে কিন্তু কোন ক্ষয়ক্ষতি হয়নি

(খ) একটি শহরে ভূমিকম্পের কারণে কয়েকটি ভবন ধসে পরেছে

(গ) ভূমিকম্পের কারণে একটি পারমাণবিক বিদ্যুৎকেন্দ্রে বিস্ফোরণ হয়েছে

৩) বিপদাপন্নতা (Vulnerability) সম্পর্কে কোনটি সত্য?

(ক) একটি এলাকায় প্রাকৃতিক দুর্যোগের ফলে সংঘটিত ক্ষয়ক্ষতির সম্ভাব্যতা

(খ) সামাজিক, ভৌগলিক, কাঠামোগত ইত্যাদি কারণে প্রাকৃতিক বা মানবসৃষ্ট আপদে আক্রান্ত হওয়ার সম্ভাবনা

(গ) একটি সমাজ ভূমিকম্পের সম্ভাব্য বিপদ সম্পর্কে কতটুকু সচেতন তার মাত্রা

৪) নিচের কোনটি ভূমিকম্পের সক্ষমতার (Capacity) উদাহরণ নয়?

(ক) কোন ব্যক্তির কাঠামোগতভাবে দুর্বল ভবনকে শক্ত করে দেওয়া

(খ) ভূমিকম্প সাড়াদানের জন্য এলাকায় প্রশিক্ষণপ্রাপ্ত স্বেচ্ছাসেবক দল তৈরি করা

(গ) কোন আর্থিকভাবে অসচ্ছল ব্যক্তির টিনের আধাপাকা ঘরকে পাকা ঘরে রুপান্তরিত করে দেওয়া

৫) নিচের কোনটি ভূমিকম্প ঝুঁকির (Risk) উদাহরণ নয়?

(ক) ভবনের দুর্বল কাঠামো

(খ) বাসার আশেপাশে খোলা জায়গা থাকা

(গ) ভূমিকম্প সম্পর্কে সচেতনতার অভাব

৬) ভূমিকম্পের কেন্দ্র (Hypocenter) কোনটি?

(ক) ভূপৃষ্ঠের উপরস্থ যেই বিন্দু থেকে ভূমিকম্পের সূচনা হয়

(খ) ভূপৃষ্ঠের উপরস্থ যেই বিন্দুতে প্রথম ভূমিকম্পের কম্পন অনুভূত হয়

(গ) ভূগর্ভস্থ যে স্থান হতে ভূমিকম্পের উৎপত্তি হয়

৭) বাংলাদেশের ভৌগলিক অবস্থানের ক্ষেত্রে কোনটি সত্য নয়?

(ক) ভূমিকম্প প্রবণ ইউরেশিয়া প্লেট, ইন্ডিয়ান প্লেট ও মায়ানমার সাবপ্লেটের মাঝখানে বাংলাদেশ অবস্থিত।

(খ) বাংলাদেশ ও আশেপাশে অবস্থিত টেকটোনিক প্লেটগুলো স্থিতিশীল অবস্থায় আছে

(গ) বাংলাদেশের ও মায়ানমারের মধ্যকার দূরত্ব ক্রমশই প্রতি বছর কমে আসছে

৮) কোনটি ভূমিকম্পের প্রাথমিক প্রভাব (Primary effect)?

(ক) সুনামি

(খ) অগ্নিকান্ড

(গ) ভূমির তরলীকরণ

৯) ভূকম্পন তরঙ্গ (Seismic wave) মূলত কত প্রকার?

(ক) ২

(খ) ৩

(গ) ৪

১০) ভূমিকম্পের মাত্রা (Magnitude) ও তীব্রতা (Intensity) সম্পর্কে কোনটি সত্য?

ক) একই ভূমিকম্পের মাত্রা সমান কিন্তু বিভিন্ন স্থানে বিভিন্ন তীব্রতা হতে পারে

খ) ভূমিকম্পের তীব্রতা পরিমাপ করা হয় সিসমোগ্রাফ যন্ত্রের মাধ্যমে

গ) ভূমিকম্পের মাত্রা পরিমাপ করতে ৩ ধরনের স্কেল ব্যবহৃত হয়

১১) নিচের কোন কাজটি দুর্যোগ প্রস্তুতির (Disaster preparedness) অংশ নয়?

ক) ঘরে খাদ্য ও জরুরি পণ্য মজুদ রাখা

খ) ভূমিকম্প হলে কি করতে হবে সে সম্পর্কে জ্ঞান অর্জন করা

গ) নিরাপদ ও ভূমিকম্প-সহনশীল ভবন নির্মাণ করা

১২) নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ বিভিন্ন ধাপের কাজগুলো পর্যায়ক্রমে/ ধারাবাহিকভাবে সংঘটিত হয়?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

১৩) নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ বিভিন্ন ধাপের কাজগুলো সমান্তরালে চলে?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

১৪) নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ আর্থ-সামাজিক অবস্থার কথা বিবেচনা করা হয়?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model

১৫) দুর্যোগের মূল কারণ (Root cause) সম্পর্কে নিচের কোন দুর্যোগ ব্যবস্থাপনা মডেল এ আলোচনা করা হয়েছে?

ক) প্রচলিত মডেল (Traditional Model)

খ) Pressure and Release Model (PAR)

গ) Expand-Contract Model