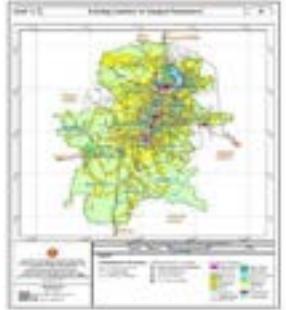
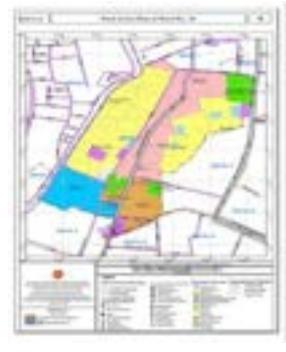




Draft Earthquake Contingency Plan Ward 14, Tangail Municipality



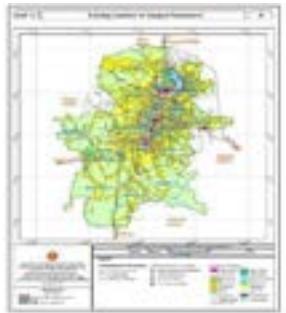
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Draft Earthquake Contingency Plan Ward 14, Tangail Municipality



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CHAPTER 1

Introduction

Earthquake can occur without any prior warning resulting in widespread damage; high numbers of fatalities and injuries; destroying buildings and other physical infrastructure and facilities. It may have adverse effect on economic, social and political sector which can drive the entire nation to disastrous consequences (CDMP, 2014). To mitigate the earthquake risk, proper planning and management are required through investigating the interrelated issues based on earthquake vulnerability assessment.

1.1 Background of the Project

Bangladesh is geographically vulnerable to earthquake due to the existence of several fault lines and tectonic plate boundaries. Historical evidences of earthquake including their severity near and within the country compound the future threat. Moreover, rapid urbanization, population growth, migration and development of economic activities are also inducing impetuous increase of vulnerability (CDMP, 2014). A severe earthquake in this country will cause a large number of human casualties, huge damages of infrastructures, social and economic loss etc. and a big earthquake is anticipated in near future (Alam et.al, 2008; CDMP, 2009; Ministry of Disaster Management and Relief, 2015). To ensure a useful response to a severe earthquake in an area; an organized earthquake risk management planning is essential at local level, including contingency plan based on seismic exposure assessment and building and socio-economic vulnerability assessment. Socio-economic vulnerability assessment reveals the community's characteristics leading to their earthquake vulnerability and the potential impact of earthquake on their social and economic life (Lal et.al, 2011). 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). In other word, contingency planning is making advance decision about human resource and financial resource management as well as ensuring communication and coordination with a range of technical and logistical responses considering possible disaster or emergency (GHI, 2014).

A brief idea about contingency plan for earthquake is also found from National Plan for Disaster Management (2010-2015). According to "National Plan for Disaster Management (2010-2015)" of Bangladesh, the pre-disaster, response and post-disaster activities are categorized into nine functional clusters to prepare plan for earthquake. They are: 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 (GoB, 2010).

Bangladesh hopes to transform from Least Developed Country (LDC) category to developing Country by 2024 through better health and education, lower vulnerability and an economic boom (UN,2018). Disaster risk reduction remains a key priority of the Government of Bangladesh, which is reflected in its Five Year Plans, Perspective Plan, Bangladesh Delta Plan and various national policies. Bangladesh has also adopted global frameworks like SDGs, Sendai Framework etc. However, Bangladesh has to maintain a holistic approach and to mainstream disaster risk reduction into development planning based on past achievements and lessons. Bangladesh government and United Nations Development Programme (UNDP), UN Women and United Nations Office for Project Services (UNOPS) have jointly initiated the National Resilience Programme (NRP) with the financial support of the Department for International Development (DFID) and the Swedish International Development Cooperation Agency (SIDA) to sustain the resilience of human and economic development in Bangladesh through an inclusive and gender responsive disaster management. The programme aims at to provide strategic support to improve national capacity to keep pace with the changing nature of disasters.

The programme consists of four sub-projects or parts. Each sub-project is implemented by one implementing partner from the Government. These implementing partners are: Department of Disaster Management (DDM) of the Ministry of Disaster Management and Relief, Department of Women Affairs of the Ministry of Women and Children Affairs, Programming Division of the Ministry of Planning, and Local Government Engineering Department of the Ministry of Local Government, Rural Development and Co-operatives.

In NRP, DDM part aims to work towards improving community resilience by creating replicable, cost-effective models around DRR inclusive social safety nets,

pro-active response solutions, earthquake preparedness, search and rescue, community-based flood preparedness that have shown promise in earlier initiatives. The objectives of the Department of Disaster Management part are:

- To advocate for implementation of the Sendai framework and build necessary capacity to monitor the implementation.
- To strengthen disability-inclusive, gender-responsive national capacities to address recurrent and mega disasters (including training of key personnel).
- To strengthen disability-inclusive, gender-responsive community preparedness, response and recovery capacities for recurrent and mega disasters.

As earthquake is a sudden perilous natural disaster and it can cause large scale damage, an inclusive earthquake risk management approach is required to minimize the loss. To ascertain an effective response to severe earthquake event; an organized earthquake risk management planning is necessary at local level, including contingency plan based on soil characteristics, structural analysis of building and socio-economical context. Realizing this National Resilience Programme (NRP) under the Ministry of Disaster Management and Relief of the People's Republic of Bangladesh has taken initiative to develop a minimum preparedness package for earthquake preparedness for the cities. Activities are implemented in Rangpur, Tangail, Rangamati and Sunamganj. This report covers preliminary contingency plan of Ward 14 of Tangail Pourashava.

1.1.1 Experience from Mymensingh Municipality

BUET and UNDP conducted similar project in Ward 14 of Mymensingh Municipality in the year 2016-2017. This research work was undertaken to develop community-based earthquake risk reduction and management plan in Ward No. 14 of Mymensingh Pourashava. For the purpose, the research team prepared a contingency plan for the study area in consultation with the local community. The tasks included assessment of seismic risk, assessment of the building and socio-economic vulnerability, and finally preparation of earthquake contingency plan for the area.

The project was launched through a workshop at Mymensingh Pourashava on 6th April 2017. This consultation workshop helped the researcher to understand the issues and to determine the scope of the work.

The earthquake contingency plan prepared to reduce seismic vulnerability of the study area includes temporary shelter planning, emergency health facility planning, Ward Co-ordination Center planning, evacuation route planning, and household level preparedness planning. For temporary shelter demand, two scenarios were considered. In Scenario-1, it was assumed that 50% residents of buildings which will collapse or damaged during an earthquake would need shelter. It was estimated that around 2,273 people would need shelter in this scenario. On the other hand, in Scenario-2, it was assumed that all the residents of the contingency plan area would require temporary shelter. Considering the preference and acceptability of local people, structural safety and accessibility of the proposed shelter, 28 places were identified for temporary shelter in dry season including open spaces, educational institutions and religious places and 24 places in wet season including open spaces, educational institutions and religious places. These places could accommodate 11,277 people in dry season and 5,209 people in wet season.

Considering preference and acceptability of local people, structural safety, and accessibility, 26 health facilities including hospitals, clinics, and diagnostic centers in the study area were proposed to serve the injured people after an earthquake. Comparing the availability and probable requirement it can be concluded that the facilities within the study area are enough to treat the estimated injured persons after an earthquake. In addition, roads that could be blocked were identified. It was found that the roads in the proposed evacuation route have road width less than or equal 6ft. These roads will be only accessible by walking, cycle or motorcycle, one-way rickshaw or van. Thus road widening initiative by the Pourashava is necessary. To access narrow roads, customized non-motorized vans can be used during a rescue operation in disaster.

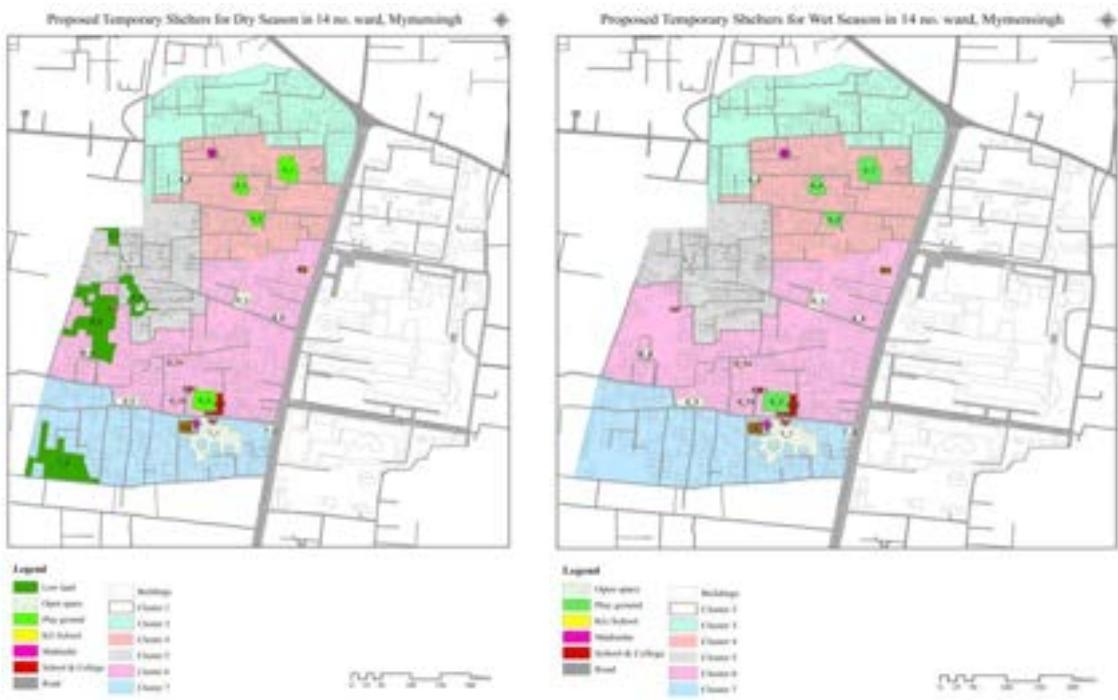


Figure 1.1: Proposed contingency plan for dry and wet season in Ward-14 of Mymensingh Pourashava

To ensure proper management of these temporary shelters and emergency health facilities, Temporary Shelters Management Committee (TSMC) and Emergency Health Facility Management Committee (EHFMC) were proposed with their composition, role, and responsibility in different phases of disaster management. These proposed committees need to coordinate their activities in consultation with the Ward Disaster Management Committee (WDMC).

From this research it was realized that earthquake vulnerability assessment of an area is required to identify the earthquake risks of an area and take precautionary measures to minimize them. A contingency plan based on the result of vulnerability is the pathway to raise awareness among the residents. This contingency plan is neither a standalone document nor a static document. It should be an ongoing process integrated and coordinated with activities of other documents.

1.1.2 Experience from Comprehensive Disaster Management Programme, Phase II

An Earthquake Contingency Plan for Tangail and Rangpur municipal area is developed through a collaborative effort among city-level disaster management and

first responder agencies as well as other relevant agencies, departments and organizations under the Comprehensive Disaster Management Programme, Phase II, in 2014. The plan aims to minimize the adverse effects of potential earthquakes by establishing and implementing a holistic response framework at town level. In April 2014, the municipality organized a training workshop on preparation of contingency plan with regard to earthquake in participation of the working group members. The results of the earthquake risk assessment and potential losses and damages for Tangail Municipality area conducted under CDMP-II and the city-level Contingency Planning template developed under CDMP-I in 2009 and revised under CDMP-II in 2012 were supplied to the group in the workshop.

A validation sensitization workshop was organized with participation of all city-level stakeholders to ensure that the plans addressed all emergency activities and issues concerns. This Contingency plan was divided into three phases: Preparation phase, Immediate Response Phase and Later Response and Recovery Phases. Preparation phase includes action strategies before the strike of earthquake. Immediate response phase incorporates the activities within initial 72 to 96 hours after a major earthquake event. Operational activities and institutional set up under city level executive committee were in this stage. Later response and recovery phase involves the activities after 72 hours some city level advocacy and plan institutionalization are on there. Moreover estimation of resource needs and analysis of resources availability were also done considering search and rescue, immediate evacuation space, evacuation routes, fire control, health facilities, emergency shelter, relief service and transportation under this plan (CDMP, 2014).

1.2 History of Earthquake

As Bangladesh is located adjacent to the borders of Indian, Burmese and Eurasian plates, it is susceptible to frequent earthquakes. Besides, the country is located close to the very active Himalayan front and ongoing deformation in nearby parts of south-east Asia expose it to strong shaking from a variety of earthquake sources that can produce tremors of magnitude 8 or greater (CDMP, 2009). Historical seismicity within Bangladesh indicates that potential for damaging moderate to strong earthquakes exist throughout much of the country. Chittagong, Sylhet, Dhaka,

Rangpur, Bogra, Mymensingh, Comilla, Rajshahi are highly vulnerable to a major earthquake disaster (CDMP, 2009). During the last 150 years, Bangladesh experienced seven earthquakes of large magnitude (Richter magnitude $M \geq 7.0$) with epicenters in India and Bangladesh (Al Hussaini, 2016). Other than that Bangladesh has regularly faced many small earthquakes. Tangail is located at the active Madhupur fault and the district is also very close to Dauki fault (Figure 1.2).

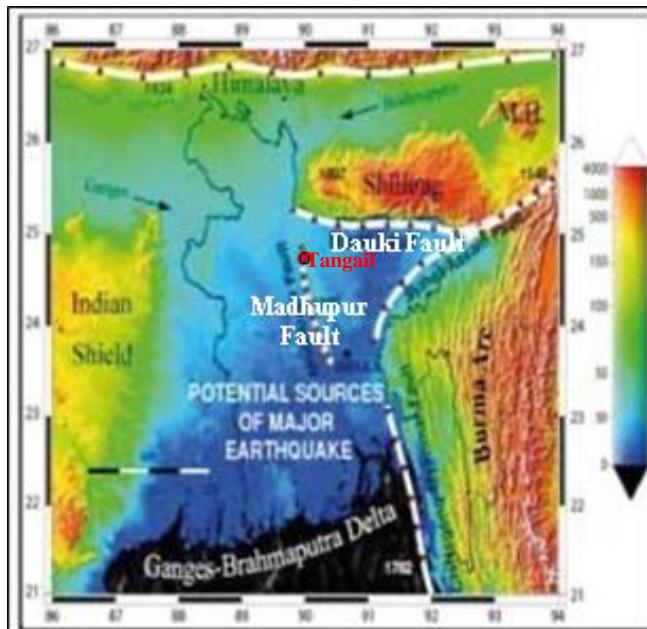


Figure 1.2: Proximity of study area to major fault lines

(Source: Akhter, 2010)

According to Revised Seismic Zoning Map of BNBC Tangail belongs to Seismic Zone 3 (Figure 1.3). The geotechnical and geophysical investigation under CDMP II shows that almost entire Pourashava area is consist of soil which is dense or stiff except Ward No. 13. This ward mostly consists of loose/ soft soil (Figure 1.4). Besides Peak Ground Acceleration (PGA) value of the wards varies up to 0.26 which has been illustrated in Figure 1.5 (CDMP, 2015).



Figure 1.3: Revised seismic zoning of Bangladesh

(Source: HBRI, 2015)

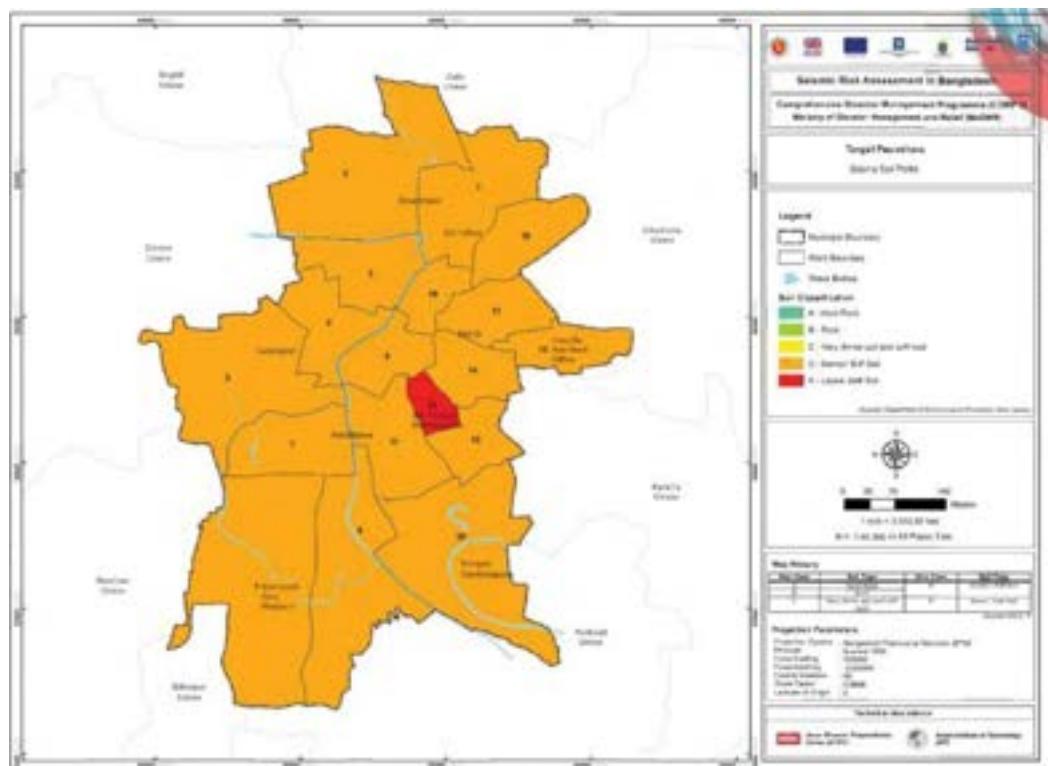


Figure 1.4: Soil Profile Map

(Source: CDMP, 2015)

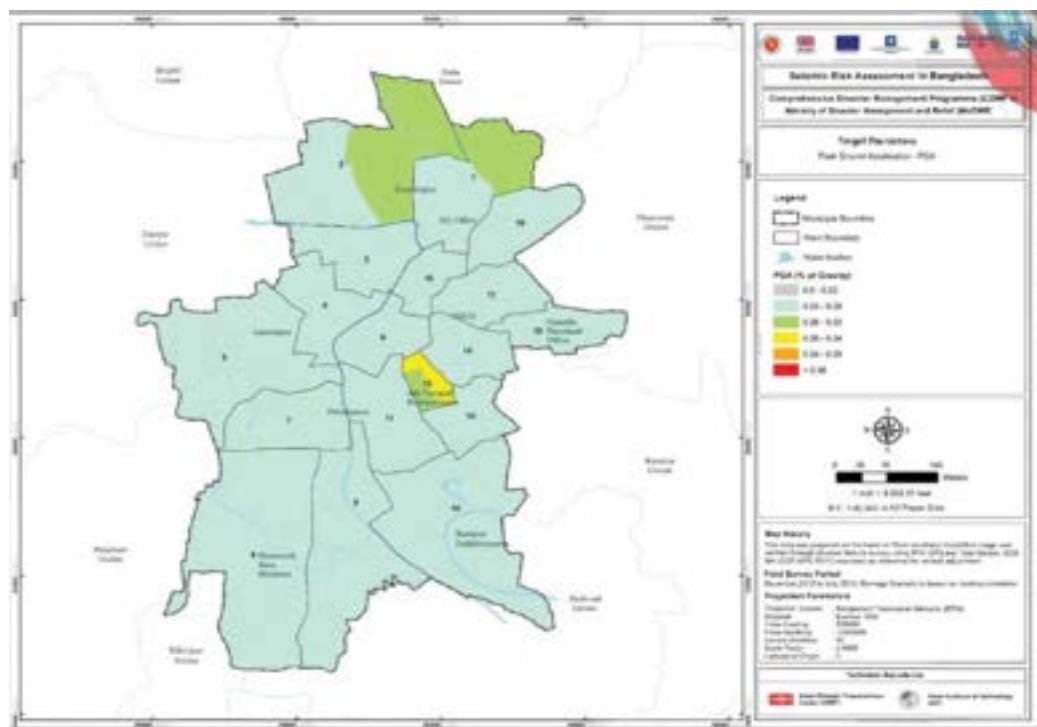


Figure 1.5: Peak Ground Acceleration Map

(Source: CDMP, 2015)

Among the wards of Tangail Pourashava, Ward no. 13 has higher PGA value than the other wards which indicates that Ward no. 13 is more susceptible to liquefaction. It is evident that Tangail faced a huge damage in the Great Indian Earthquake in 1897.

1.3 Aim and Objectives of the Project

1.3.1 Aim of the Project

The aim of the assignment is “building earthquake resilient community through vulnerability assessment, capacity and awareness building and promoting safe construction practices”.

1.3.2 Objective of the Project

The objective of the assignment is to formulate community-based earthquake preparedness and management plan in Rangpur City Corporation and Tangail, Sunamganj and Rangamati Pourashavas. The task includes participation of

community and engagement of their intuitions in assessment, planning, capacity and awareness building.

1.4 Scopes of the Project

The scope of the project involves assessment of earthquake vulnerability and response capacity of Rangpur City Corporation and Tangail, Rangamati and Sunamganj pourashavas. The contents of training on earthquake preparedness would be prepared for trainers and training would be also imparted in this assignment. Guidelines for Risk Sensitive Land Use Planning based on the vulnerability assessment would be developed with Ward Level Risk Reduction Action Plan. Ward and household level Contingency Plan would be developed with household level information. To facilitate awareness campaign in an inclusive manner, education and communication materials would be prepared. Adequate policies would be identified for proper building approval, building code enforcement and construction monitoring by the local government.

It should be mentioned here that the proposal for institutional set up for different components of the contingency plan as well as household level contingency plan would be covered in the first volume of the report.

1.5 Organization of the Report

There are five chapters in this report. In chapter one, background and objectives of the research have been discussed. Chapter two focuses on the profile of study area including the geographic, demographic and other characteristic of the study area. Chapter three describes the sequential steps of methodology through which the aim and objectives of this research have been achieved. Chapter four includes earthquake contingency plan. Chapter five concludes with some future scopes of this contingency plan during and after an earthquake event.

CHAPTER 2

Study Area Profile

Tangail Pourashava is situated at Tangail district in Dhaka division. It is located on the Seismic Zone-3 of Bangladesh and was established in 1984 (BBS, 2011). The total population is 167412 with density of 1559 persons per sq.km (BBS, 2011). Among the 18 Wards of Tangail Pourashava, Ward No 14 was selected as the study area for this project.

2.1 Location of the Study Area

The study area is located at the north-eastern corner of the Pourashava. Figure 2.1 shows the location of the Tangail Pourashava in Tangail Sadar Upazila as well as the Ward map of Ward 14.

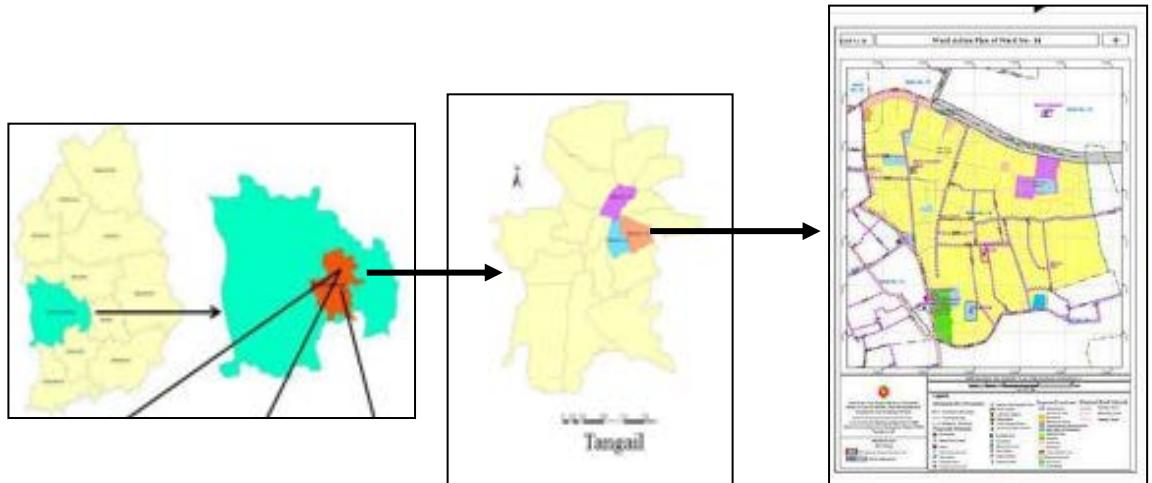


Figure 2.1: Location map of study area
(Source: Tangail Pourashava, 2010)

2.2 Demographic Profile of the Study Area

The population of the Ward 14 is 11786 (BBS, 2011). The ratio of male and female population, average household size and literacy rate of ward 14 of Tangail Pourashava is included in Table 2.1.

Table 2.1: Male, female ratio, HH size and literacy rate of the study area

Ward No	Male (%)	Female (%)	Average Household (HH) Size	Literacy Rate (%)
Ward 14	51.4	48.6	4.1	79.1

(Source: BBS, 2011)

Table 2.2 shows the age-wise distribution of population at Ward 14 of Tangail Pourashava which can contribute to the social vulnerability of the area. Service is the dominant occupational activities of the study area over the agricultural and industrial activities.

Table 2.2: Age-wise distribution of population at the study area

Ward No	Percentage of Population at Different Age Group					
	0-9	10-19	20-29	30-49	50-59	60+
Ward 14	15.9	22.5	20.1	28.7	6.9	5.9

(Source: BBS, 2011)

2.3 Existing Land Use of the Study Area

Figure 2.2 reveals that the major land use of Ward no 14 is residential. The density of residential land use is higher in the northern part of the Ward than the southern part. An ample amount of open spaces are found in the southern portion of Ward 14. Commercial and mixed land uses are basically found near the northern and the north-western part of the ward. The north-eastern corner of the Ward is Industrial land use based. Health and community facility based land uses are in the lowest percentage in this Ward 14. The road network covers a major portion of land though most of the roads are too narrow to access. A significant number of water bodies are also present in the ward. Land uses for educational, administrative and religious purpose are also found in Ward 14.

2.4 Profile of Built Structure in the Study Area

If the structures are described according to their types it is found that 33% of the structures of Ward No. 14 of Tangail Pourashava are pucca, 32% are semi pucca and the rest are kutcha. Number of stories varies from 1 to 10 among the pucca buildings. Distribution of pucca building according to their stories is shown in Table 2.3.

Table 2.3: Distribution of pucca structures according to number of storey

Number of Story	Number of structures
Number of 1 to 3 storied building	702
Number of 4 to 6 storied building	146
Number of 7 or higher storied building	14
Total	862

Source: (Field Survey, 2020)

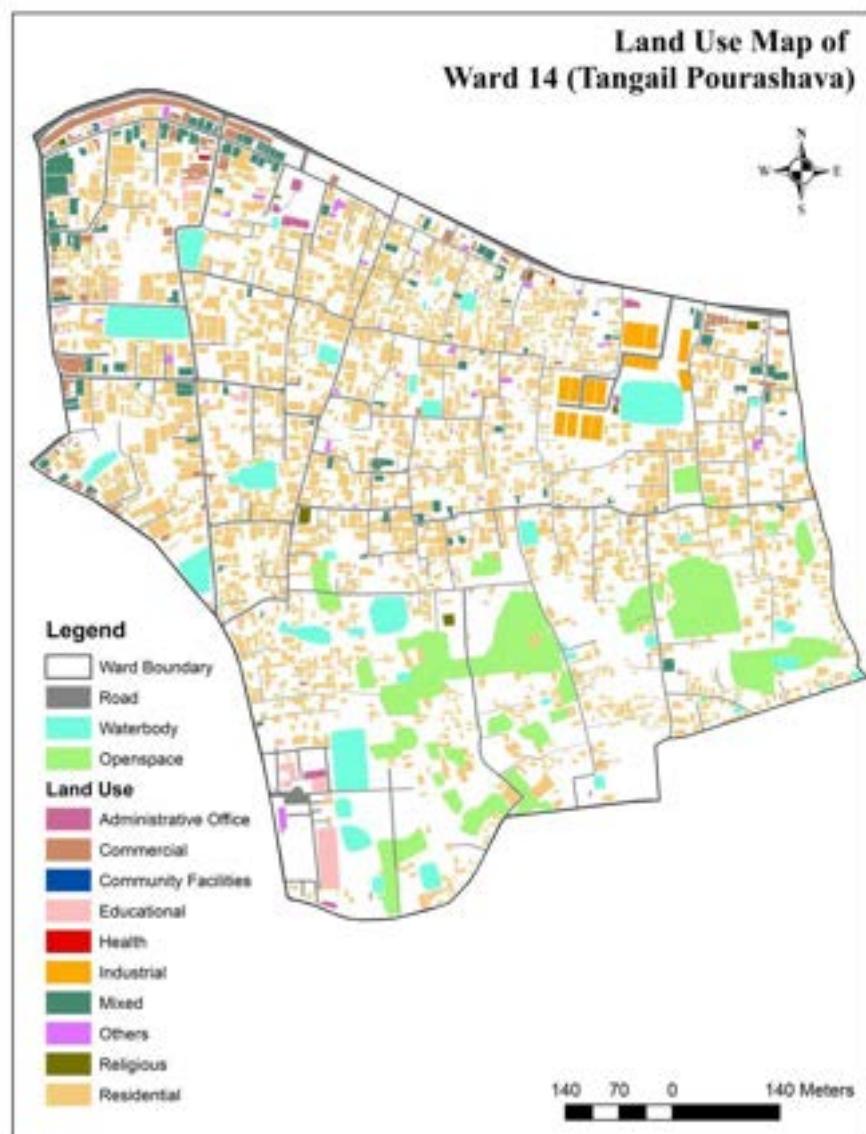


Figure 2.2: Map showing land use of the study area

(Source: Field Survey, 2020)

Among the surveyed buildings, 85% are of residential use, followed by commercial uses (5%) and mixed uses (4%). There are only three buildings for health facilities in the locality. Apart from these uses, some buildings are used for community facilities. Figure 2.3 shows frequency of different building uses in Ward 14 of Tangail Pourashava.

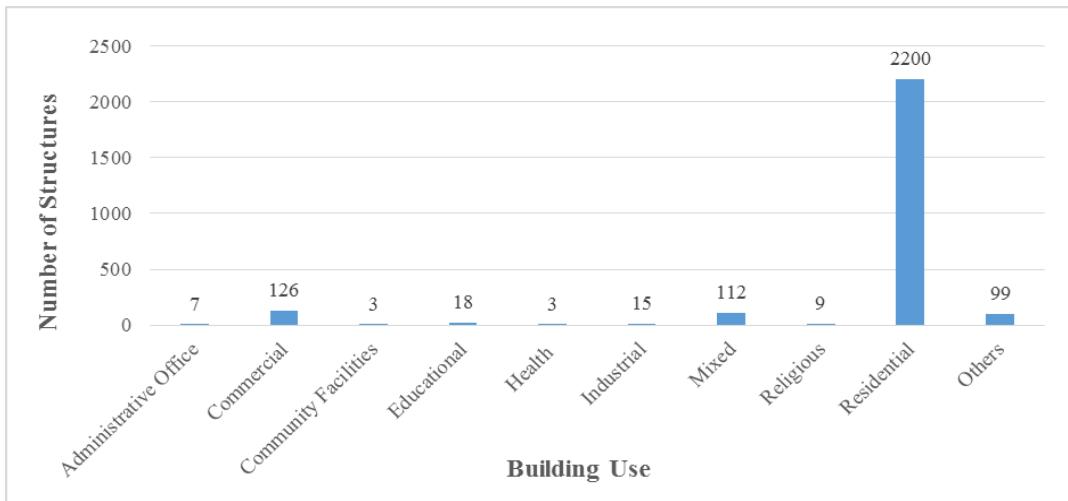


Figure 2.3: Distribution of structures according to building use
(Source: Field Survey, 2020)

There are total 40 institutional buildings in Ward 14 which are of both public and private ownership. Buildings for administrative purpose educational and religious use, health facility and community facilities have been considered as public building in this project. Among them, 7 buildings are administrative offices, 18 buildings are educational, 3 buildings provide health facilities, 9 buildings are for religious purpose and 3 buildings are for community facilities.

CHAPTER 3

Methodology

3.1 Introduction

There is no unique method to determine socio-economic and building vulnerability of community due to earthquake. As contingency plan is dependent upon socio-economic and physical context, a comprehensive methodology is needed to cover the issues. Thus a comprehensive approach has been considered in this research to prepare the earthquake contingency plan considering physical vulnerability of the area as well as socio-economic vulnerability of community. For this research, both primary and secondary data were collected. A questionnaire survey and engineering survey were conducted to understand the socio-economic context and physical vulnerability of the area and structures. In addition, secondary data on land use, institutional capacity were collected. Once the data were collected, it was verified, processed and analyzed. In the whole process of primary data collection, local community were involved closely considering that they have better knowledge about their community and also with an aim to develop local capacity. Based on the collected data and community participation through workshop, earthquake contingency plan will be prepared. Later in this project, community-based approach will be taken for capacity and awareness building and promoting safe construction practices. The following sections provide the detail description of the methodology.

3.2 Study Area Selection

To ensure an effective response to a severe earthquake, this project has been initiated under National Resilience Programme (NRP) for Rangpur City Corporation; and Tangail, Rangamati and Sunamganj Pourashavas. All of these areas are located on severe or very severe risk seismic zone of Bangladesh (Figure 1.1) as well as there are many historical evidences of major earthquake within or close to these areas as mentioned in Chapter 1. Moreover, these areas have been opted over the whole upazila because unabated growth of human settlement and establishment of important institutions within municipal area are took place within these areas. Besides haphazard urbanization and sub-standard construction of buildings and other

infrastructures without consideration of BNBC are increasing with time. In addition, the foundations and supports of structures built on the highly liquefiable sediment can fail causing damage or destruction during major earthquakes in the municipality. Poor institutional and community awareness about the risks and consequences of earthquake also exist within the selected municipalities.

Three Wards of each area were selected further by UNDP to conduct the study. These Wards were selected based on some area characteristics like: high population density, concentration of high-rise buildings with narrow lanes, lack of adequate fire extinguishers at buildings, tightly packed business center/market, lack of open space, density of educational institutions and healthcare facilities, low income community living without or lack of critical facilities etc. For convenience of contingency planning, it was also ensured that the three Wards in one area must be adjacent. Finally, twelve Wards from these four (4) areas (three from each area) were chosen based on above mentioned criteria. For Tangail Pourashava, Ward No. 13, 14 and 16 were selected. Among them, Ward No. 14 of Tangail Pourashava is considered as the study area for this report.

3.3 Project Initiation

The project was initiated in Tangail Pourashava through inauguration workshop in an interactive way at Tangail Pourashava Office on 7th November, 2019. In this workshop, the aims and objectives of this project were introduced and explained. The Honorable Mayor of Tangail Pourashava Mr. Md. Jamilur Rahman Miron chaired the workshop. The Honorable Project Director of NRP along with other officials from UNDP attended the workshop. In this workshop, Prof. Dr. Mohammad Shakil Akhter and Mr. Md. Aminul Islam were present from BUET. The local participants of the workshop were: Ward Councilors of Tangail Pourashava, government officials, members from civil society, volunteers from Bangladesh Red Crescent Society, and National Cadet Corps.



Figure 3.1: Inauguration Workshop

In the workshop, firstly UNDP presented the objective of the NRP along with this project. Then, the work plan and expected outcomes of this project were discussed by BUET. After the presentation session, an open discussion session took place among the participants. The participants provided their suggestions about how this program can be made successful and expressed their willingness to support the authorities in this process.

3.4 Secondary Data Collection

For the purpose of this project, data were collected from different secondary sources. From Tangail Pourashava office, the GIS database of the study area was collected, which is the main basis for this project. It contains data on area boundary, structures type, land use and road network. This database was used to prepare the base map of the study area. The database was last updated in the year of 2010. Considering the huge development in the study area from 2010 to 2019, it was necessary to verify and update the database. In this regard, Google Earth satellite image of the study area was collected and utilized, where the latest images were available for the year 2018. At the preliminary stage, the land cover and in some cases land use were identified by using Google Earth tag. Additionally, the newly built structures, water bodies, open spaces, barren lands etc. were digitized. In this way, the GIS database of the study area was primarily updated based on satellite image. From the update, it had been found that almost 356 new buildings were constructed in between 2010-2018. Data on socio-demographic profile of the study area were collected from BBS. Some policy documents such as Building Construction Rules (1996) and project reports

such as Comprehensive Disaster Management Programme (CDMP) for Tangail Pourashava were collected and reviewed to identify the previously collected data on development pattern, soil characteristics etc. of the study area.

3.5 Primary Data Collection

For this project, primary data were collected, which included physical observation survey for GIS database verification and updating, borehole test and micro-tremor test for assessment of seismic exposure, building survey for preliminary vulnerability assessment of buildings through Rapid Visual Screening (RVS) method, household questionnaire survey and checklist survey for social vulnerability assessment and contingency planning for earthquake, and engineering survey of buildings for detailed vulnerability assessment of buildings through Details Engineering Assessment (DEA). Primary data collection methods are described in the following sections:

3.5.1 Primary Data Collection for GIS Database Verification and Updating: Physical Observation Survey

The preliminary updated GIS database based on Google Earth satellite image was finally verified and updated through physical observation survey. Here, the preliminary updated GIS database was utilized to prepare the base maps to be verified and updated. For ease of data collection and planning, the study area was divided into 12 clusters in consultation with local people considering the area of the clusters and the density of structures in the clusters. Appendix A shows the designated clusters in the study area. These clusters were utilized throughout this project for data collection, assessment and earthquake contingency planning. Thus cluster wise base maps were prepared utilizing preliminary updated GIS database to carry out the physical observation survey.

Through physical observation survey, it was intended to verify and update data on the location of the water bodies, open spaces, barren lands, road network, etc. as well as the building information. To collect data of building information, a checklist was prepared which is shown in Appendix B. The attributes considered include detailed building use, type of structure, number of storey, width of adjacent road, etc. To ensure digital data collection and real time data management, “KoBo Toolbox” was

utilized for data collection. Thus, after preparation of the checklist, it was prepared in “KoBo Toolbox” and was tested to ensure workability.

After preparation of base maps and checklist in “KoBo Toolbox”, the physical observation was conducted from December 03, 2019 to December 10, 2019. For the purpose of data collection in the study area six groups were formed consisting of two members each. These surveyors were local volunteers from Bangladesh National Cadet Corps (BNCC). These groups were supervised by research assistants and technical officials from BUET to ensure accuracy in data collection.

Once the field survey was completed, the preliminary updated GIS database was updated and finalized incorporating all the collected data. According to the updated database, there are total 862 pucca structures, and 1730 katcha and semi-pucca structures in the study area.

3.5.2 Primary Data Collection for Assessment of Site-Specific Seismic Hazard

In order to assess the site-specific seismic hazard of the study area, two bore holes up to a depth of 30 meters were conducted in the study area. Disturbed and undisturbed samples were also collected from different depths. Figure 3.2 shows the location of the bore holes. The locations were selected based on the geological data presented in the report of CDMP-II (2015).

Microtremor tests were conducted using five velocity sensors each having three channels. The channels collected data in north-south, east-west and up-down directions. For each sensor the X axis was aligned with north. Each sensor was placed 25 meters apart. Precautions were taken to avoid noises and vibrations from other external sources so that they do not hamper the recording of the ambient vibration. Figure 3.3 shows the location of Microtremor tests in the study area (Ward No. 14, Tangail Pourashava). These tests were conducted between December 01-10, 2019.

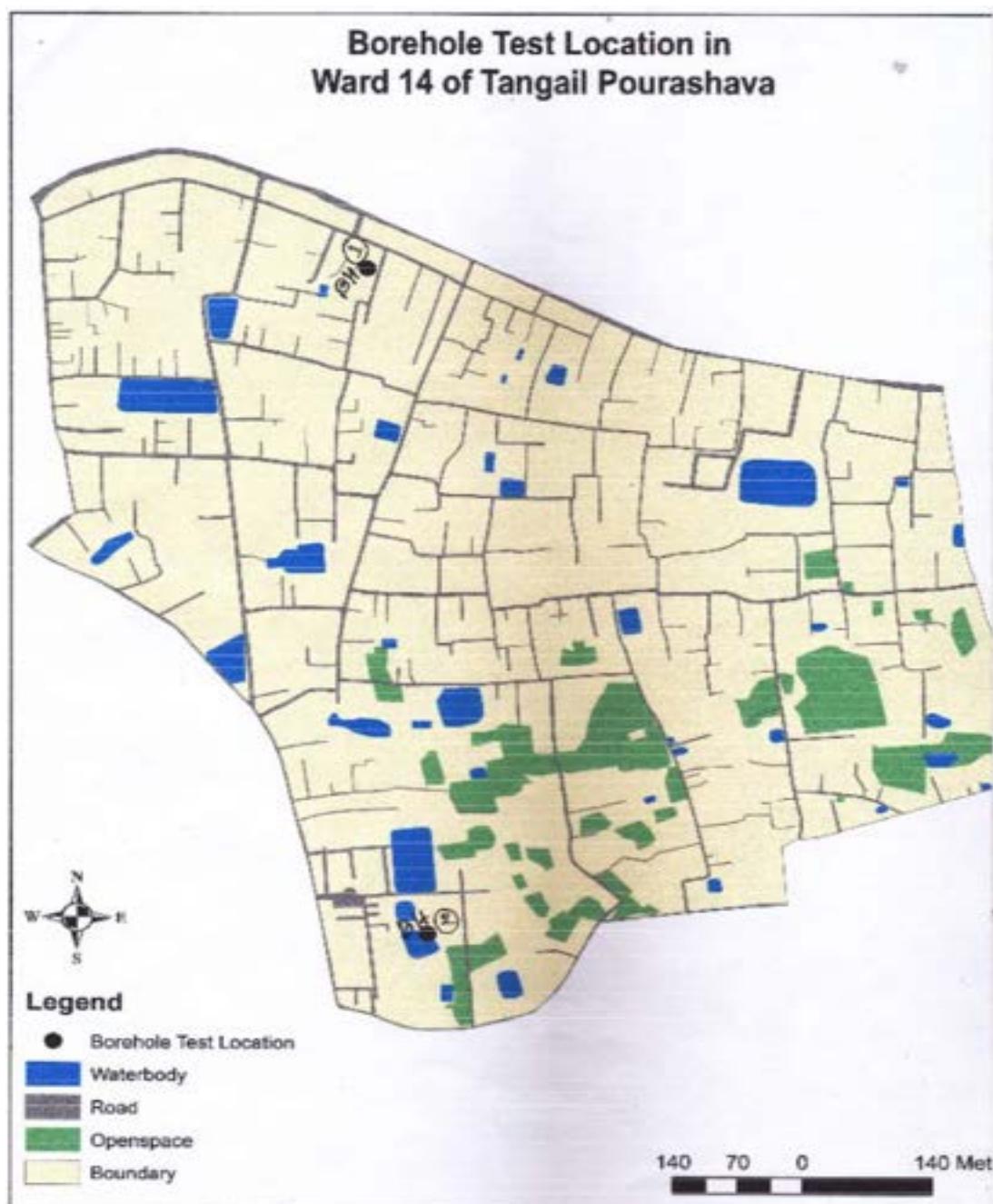


Figure 3.2: Location of boreholes

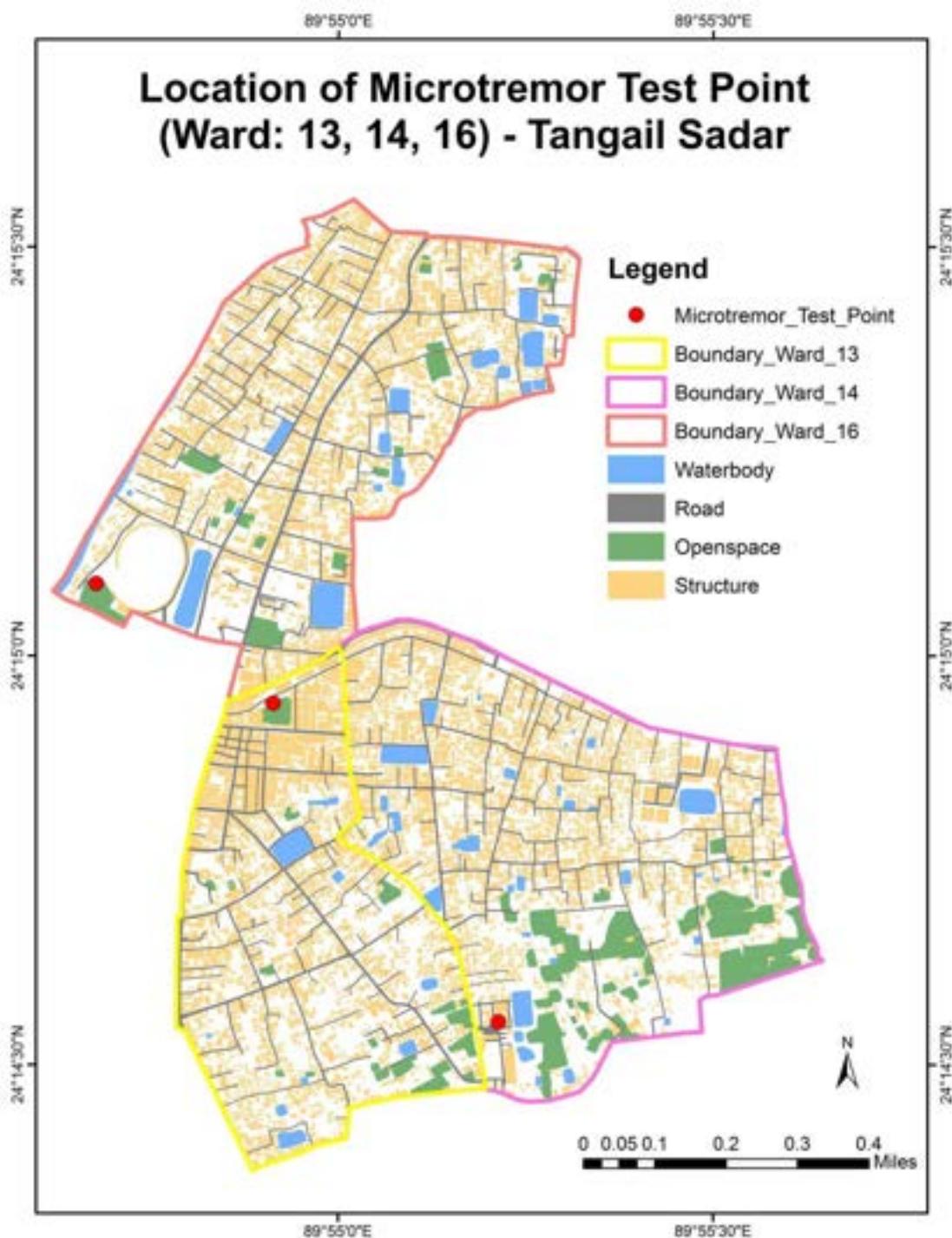


Figure 3.3: Microtremor test location

3.5.3 Primary Data Collection for Preliminary Vulnerability

Assessment of Buildings: Rapid Visual Screening (RVS) Method

To assess the preliminary vulnerability of the buildings in the study area, Level 1 survey of RVS (Rapid Visual Screening) suggested by FEMA (Federal Emergency Management Agency, USA, 2017 edition) was adopted. Rapid Visual Screening (RVS): FEMA P-154 was developed by ATC (Applied Technology Council) on behalf of FEMA. Its purpose is to provide a methodology to evaluate the seismic safety of a large inventory of buildings quickly and inexpensively, with minimum access to the buildings, and determine those buildings that require a more detailed examination (FEMA, 2017). It is a sidewalk survey process that enables to classify the surveyed buildings into two categories: those that may not pose risk to life and those that may be seismically hazardous and should be investigated in more details by a design professional experienced in seismic design.

To collect data in this regard, firstly sample size was determined, the base maps and form for data collection was prepared and finally the related data were collected. These methods are described below:

3.5.3.1 Sampling of Buildings

According to the contract between DDM and BUET, the total sample size in this regard from all the study areas of this project (Section 3.2: Study Area Selection: Total 12 Wards in three Pourashavas and one City Corporation consisting of three Wards each) would be 2000 pucca buildings. Considering the human error in data collection process, BUET team decided to collect data from 2207 pucca buildings. The sample buildings were distributed in 12 Wards (Section 3.2: Study Area Selection: three Pourashavas and one City Corporation consisting of three Wards each) through proportional distribution based on number of pucca buildings in each Wards accordingly (considering updated databases). Thereby, the sample size in the study area of this report (Ward No. 14 of Tangail Pourashava) for preliminary vulnerability assessment through RVS method was found total 151 pucca buildings. For selection of these 151 sample pucca buildings in the study area, the following three criteria were considered.

a) Institutional and administrative uses: Here all the government administrative offices and institutional facility buildings (including health, educational, religious and community facility) were labeled as institutional and administrative buildings, and the rest were considered as buildings of other uses. All of the buildings from this category irrespective of their number of storey were selected for preliminary vulnerability assessment. These buildings will be considered in contingency planning purpose for disaster shelter, emergency health facility and Ward Co-ordination Center.

b) Buildings of other uses with number of storey 4 or more: All of the buildings falling within this category were considered for preliminary vulnerability assessment. If these buildings collapse or damage after an earthquake, they may create debris blocking the roads and thus hampering emergency management after an earthquake.

c) Buildings of other uses with number of storey 1 to 3: Rest of the sample buildings were selected from this category. To understand the performance of the buildings within this category as 84% of the total pucca buildings fall within this category. Representation from all of the clusters in the study area was ensured through proportional distribution of the sample size. The sample buildings within this category were selected arbitrarily through discussion with local people.

Table 3.1 shows sample size of buildings selected from different categories with respect to total number of buildings, for preliminary vulnerability assessment through RVS method. Table 3.2 shows the number of samples in each cluster of the study area.

Table 3.1: Sampling of pucca buildings for preliminary vulnerability assessment through RVS method

Building use	Institutional and Administrative		Other uses			Total
	1-3 Storey	3+ Storey	1-3 Storey	4-6 Storey	6+ Storey	
Total number of buildings	19	4	725	97	17	862
Sample size	19	4	14	97	17	151
	23		128			

Table 3.2: Number of samples in each cluster

Cluster No.	Building use		Total sample
	Institutional and Administrative	Other uses	
0	1	5	6
1	3	7	10
2	4	27	31
3	6	13	19
4	1	8	9
5	0	22	22
6	0	17	17
7	2	11	13
8	0	3	3
9	0	2	2
10	1	10	11
11	0	0	0
12	5	3	8
Total	23	128	151

3.5.3.2 Base Map and RVS Form Preparation

After sample size determination, base maps indicating the sample buildings were prepared in ArcGIS based on updated GIS database. For convenient and organized data collection, cluster wise base maps were prepared accordingly showing the sample buildings.

For preliminary vulnerability assessment of the sample buildings of the study area through RVS method (Level 1) the form recommended by FEMA was utilized (Appendix C). To ensure digital data collection and real time data management, “KoBo Toolbox” was utilized for data collection. Thus, the form of FEMA for RVS (Level 1) survey was prepared in “KoBo Toolbox” and was tested to ensure workability. The attributes included in this form are: the building identification information, picture of building, information of use, floor area, number of story as

well as some pertinent data related to seismic performance e.g. vertical irregularity, seismic force resisting system, structural materials of the buildings, plan irregularity, pounding potential and the effect of surrounding structure, geological features on the site, non-structural hazards etc.

3.5.3.3 Data collection

After preparation of the cluster wise base maps showing sample buildings and the RVS (Level 1) form in “KoBo Toolbox”, the preliminary building vulnerability assessment survey was conducted from January 25, 2020 to February 03, 2020 (Figure 3.4). For the purpose of data collection in the study area three groups were formed consisting of two members each. These surveyors were local volunteers who are students of Civil Engineering Department of local polytechnic institute (Tangail Polytechnic Institute). These groups were supervised by research assistants and technical officials from BUET to ensure accuracy in data collection. To ensure cooperation and proper response from the local people, an announcement was done in the study area before starting the data collection by Tangail Pourashava informing them about the survey.



Figure 3.4: A group headed by a technical person during field-work

3.5.4 Primary Data Collection for Social Vulnerability Assessment and Contingency Planning for Earthquake: Household Questionnaire Survey

To collect data for social vulnerability assessment and preparation of earthquake contingency planning for the study area, household questionnaire survey was

conducted. To collect data in this regard, firstly sample size was determined, the base maps and questionnaire for data collection were prepared and finally the related data were collected. These methods are described below:

3.5.4.1 Sampling of Households

According to the contract between DDM and BUET the total sample size in this regard from all the study areas of this project (Section 3.2: Study Area Selection: Total 12 Wards in three Pourashavas and one City Corporation consisting of three Wards each) would be 2000 households. Considering the human error in data collection process, BUET team decided to collect data from 2200 household. For appropriate representation and to avoid repetition, it was considered that one sample household would be selected from one residential structure. Thus, the total 2200 sample residential structures (representing one sample household each) were distributed in 12 Wards (Section 3.2: Study Area Selection: three Pourashavas and one City Corporation consisting of three Wards each) through proportional distribution based on number of residential structures in each Wards accordingly (considering updated databases). Thereby, the sample size in the study area of this report (Ward No. 14 of Tangail Pourashava) for household questionnaire survey was found total 239 households from 239 residential structures. For selection of these 239 residential structures in the study area, two following criteria were considered.

- a) Residential buildings with number of storey 4 or more:** All four storied or higher residential buildings in the study area were considered to select sample households (one from each) for household questionnaire survey. If these buildings collapse or damage after an earthquake, they may create debris blocking the roads and thus hampering emergency management after an earthquake. This will make implementation of the contingency plan more challenging. Therefore, representation from these buildings was considered a must.
- b) Residential buildings with number of storey 3 or less, and katcha and semi pucca residential structures:** The remaining sample buildings were selected from these two categories proportionally to ensure representation of households from these buildings and structures. Representation from all of the clusters in the study area was

ensured through proportional distribution. The sample buildings within this category were selected arbitrarily through discussion with local people.

The decision for retrofitting of residential buildings (if necessary) would depend on perception of building owners. Therefore, it was necessary to consider the owner's households for the household questionnaire survey. Again, the tenants would also respond and suffer the impact of an earthquake in their area. Hence, the perception of the tenants was also necessary to be understood. Paying attention to this issue, proportion for distribution of households of owners and tenants within the determined sample size was considered 70% and 30% accordingly. Thus, after determination of the sample size of buildings representing one sample household each for household questionnaire survey, they were distributed among owners and tenants considering the above mentioned proportion. To ensure representation from all of the clusters in the study area, owner's and tenant's sample households were determined from different clusters proportionally.

Table 3.3 shows sample size of buildings selected from different categories with respect to total number of buildings for household questionnaire survey along with their proportion among owners and tenants. Table 3.4 shows the number of samples in each cluster of the study area.

Table 3.3: Sampling of residential buildings for household questionnaire survey

Number of storey	Katcha and Semi Pucca	Pucca 1- 3 Storey	Pucca 4-6 Storey	Pucca 6+ Storey	Total
Total number of buildings	1529	627	139	13	2308
Total sample size	60	25	141	13	239
Sample size for owners (70% of total sample size)	40	16	97	9	162
Sample size for tenants (30% of total sample size)	20	9	44	4	77

Table 3.4: Cluster wise sampling of residential buildings for household questionnaire survey

	Katcha and Semi Pucca			Pucca 1 to 3 Storied			Pucca 4 to 6 Storied			Pucca 6+ Storied			Total		
	Owner	Tenant	Total	Owner	Tenant	Total	Owner	Tenant	Total	Owner	Tenant	Total	Owner	Tenant	Total
Cluster 1	3	1	4	1	1	2	21	9	30	4	2	6	29	13	42
Cluster 2	3	1	4	2	1	3	19	8	27	2	1	3	26	11	37
Cluster 3	7	3	10	1	1	2	10	5	15	0	0	0	18	9	27
Cluster 4	2	1	3	2	1	3	6	3	9	0	0	0	10	5	15
Cluster 5	5	2	7	3	1	4	15	7	22	0	0	0	23	10	33
Cluster 6	3	2	5	1	1	2	5	2	7	2	1	3	11	6	17
Cluster 7	2	1	3	1	1	2	8	4	12	1	0	1	12	6	18
Cluster 8	4	2	6	1	0	1	2	1	3	0	0	0	7	3	10
Cluster 9	3	2	5	1	1	2	2	1	3	0	0	0	6	4	10
Cluster 10	2	1	3	1	0	1	6	3	9	0	0	0	9	4	13
Cluster 11	3	2	5	1	0	1	1	0	1	0	0	0	5	2	7
Cluster 12	3	2	5	1	1	2	2	1	3	0	0	0	6	4	10
Total	40	20	60	16	9	25	97	44	141	9	4	13	162	77	239

3.5.4.2 Base Map and Questionnaire Preparation

After sample size determination, base maps indicating the sample buildings (specifying owners' and tenants' households) were prepared in ArcGIS based on updated GIS database. For convenient and organized data collection, cluster wise base maps were prepared accordingly showing the sample buildings.

Firstly, a draft questionnaire was prepared for collection of data for household questionnaire survey based on review of different related literatures. While preparing the questionnaire the following issues were taken into consideration: the general information of the respondent and household, respondent's awareness, knowledge and perception on earthquake, respondent's ideas about earthquake disaster management, and owner's consent to earthquake risk reduction. After preparation of the draft questionnaire, pilot surveys were conducted for six households in the study area on 9th December, 2019. The purpose of the pilot surveys was to check the consistency, to identify the complexities or gaps of the questionnaire, and to develop the mechanism and approach for the survey. After the piloting, the questionnaire was finalized addressing the shortcomings accordingly which is shown in (Appendix D). To ensure digital data collection and real time data management, "KoBo Toolbox" was utilized for data collection. Thus, after preparation of the final questionnaire, it was prepared in "KoBo Toolbox" and was tested to ensure workability.

3.5.4.3 Data collection

After preparation of the cluster wise base maps showing sample buildings and the questionnaire in "KoBo Toolbox", the household questionnaire survey was conducted in the study area from January 25, 2020 to February 03, 2020 parellaly with the preliminary building vulnerability assessment survey (Figure 3.5). For the purpose of the survey, three groups were formed consisting of two members each. These surveyors were local volunteers from Red Crescent Society. These groups were supervised by research assistants and technical officials from BUET to ensure accuracy in data collection. To ensure cooperation and proper response from the local people, an announcement was done in the study area before starting the data collection by Tangail Pourashava informing them about the survey.



Figure 3.5: Data Collection-Household Survey

3.5.5 Primary Data Collection for Contingency Planning for Earthquake: Checklist Survey

For contingency planning for disaster shelter and emergency health facility, it was necessary to collect basic data about the facilities potential to be used for this purpose. In this regard, checklist survey was necessary to be conducted for potential disaster shelters (educational facilities, religious facilities, community centers, etc.) and emergency health facilities (hospital, clinic and other health facilities). In this regard, firstly relevant checklists were prepared to collect data from different facilities in the study area accordingly. These checklists are given in Appendix E. After preparation of the checklists, the checklist surveys were conducted in the study area from January 25, 2020 to February 03, 2020 parellaly with preliminary building vulnerability assessment and household questionnaire survey.

3.5.6 Training of the Volunteers for Data Collection

Local community plays the role of first responders in case of any disaster. Therefore, strategies for local empowerment and capacity building are needed in order to ensure effective disaster mitigation (Shaw, 2012). Moreover, local people are familiar with their locality and have greater knowledge about their community. Due to their local residency, community people have greater trust on them and also they feel at ease to respond to them. Thus, community-specific training programme is an important tool which utilizes local knowledge and enhances the potential of local residents (Rivas and Kilmer, 2016). Considering these, one of the goals of the project is to engage the people of the community in all the phases in order to build their capacity. Therefore, in this project local people were involved in the whole process of data collection for GIS database verification and updating, preliminary building vulnerability assessment and household questionnaire survey. To involve them in the process, their

capacities were developed through training programs. The training programs conducted in the study area for capacity building of local people the data collection at different phases in this project are discussed below:

3.5.6.1 Training on Data Collection for GIS database Verification and Updating

This training program was scheduled to be organized on 3rd December, 2019. It was estimated that six groups would be required to be formed consisting of two members each. Here mix of male and female surveyors was considered preferable. In this regard, one week before the training program, local representatives were contacted to communicate and organize minimum local volunteers (male and female) interested to involve in the data collection process. The criteria for participating in the data collection process was that the volunteers should be educated (student or graduate) and should have active android smart phones capable of operating “KoBo Toolbox”.



Figure 3.6: Training of local volunteers from BNCC regarding the map updating process

On 3rd December, 2019 (Tuesday) the training program was organized at the seminar room of Society of Social Service (S.S.S) Rest House (Figure 3.6). Considering the criteria total 16 volunteers participated in the training program among which ten were male and six were female. They are local volunteers from Bangladesh National Cadet Corps (BNCC). The training program was conducted by the research assistants and technical officials from BUET. At the initiation of the training program, firstly the participants and the instructors were introduced to each other. After that the instructors presented a presentation explaining the project background and how it would help the local people to address earthquake risk in their area, rationale for selecting the study area in Tangail Pourashava, and the purpose and importance of the physical observation survey for verification and updating the GIS database for

the project. After that the volunteers were trained regarding the survey procedure, i.e. how to read the base maps, introduction and explanation of different variables in the checklist for data collection, and the process of data collection using “KoBo Toolbox” mobile application. This training session was interactive, where the volunteers asked questions for necessary clarification. At the end of the training, the volunteers were divided into six (6) groups to carry out the physical observation survey for data collection in the study area for GIS database verification and updating.

3.5.6.2 Training on Data Collection for Preliminary Building Vulnerability Assessment and Household Questionnaire Survey

For convenience of work, it was intended to carry out the preliminary building vulnerability assessment and household questionnaire survey simultaneously. Therefore, the training programs for preliminary building vulnerability assessment and household questionnaire survey were organized together, which was scheduled to be organized on 25th January, 2020. It was estimated that nine groups would be required to be formed consisting of two members each for preliminary building vulnerability assessment survey. The criteria for the volunteers for this survey were: should have civil engineering knowledge, educated (student or graduate) and should have active android smart phones capable of operating “KoBo Toolbox”. Similarly, nine groups were estimated to be formed consisting of two members each for household questionnaire survey. The criteria for the volunteers for this survey were: should have capacity to communicate with people, educated (student or graduate) and should have active android smart phones capable of operating “KoBo Toolbox”. In this regard, one week before the training program, local representatives were contacted to communicate and organize local volunteers interested to involve in the data collection process accordingly fulfilling the criteria.



Figure 3.7: Training program to conduct data collection for preliminary building vulnerability assessment and household questionnaire survey

On 25th January, 2020 at 10.30 am the training program was organized at the conference room of Tangail Pourashava (Figure 3.7). Considering the criteria, total 18 volunteers participated in the training program from the Civil Engineering Department of local Polytechnic Institute (Tangail Polytechnic Institute) for preliminary building vulnerability assessment survey, and 18 volunteers from Red Crescent Society for household questionnaire survey. The training program was conducted by the faculty members, research assistants and technical officials from BUET.

The program consisted of three sessions. The first session was the formal inauguration. Firstly, the participants and the instructors were introduced to each other. A presentation on brief summary of the project and the objective of the work was given. After that the instructors presented a presentation explaining the project background and how it would help the local people to address earthquake risk in their area, rationale for selecting the study area in Tangail Pourashava, and the purpose and importance of the preliminary building vulnerability assessment and household questionnaire survey. At the end of this session, a lecture on map reading was given. Here the base maps were introduced to the volunteers and they were instructed how to locate the survey buildings reading the map.

After the formal inauguration, the volunteers for preliminary building vulnerability assessment and household questionnaire survey were separated to start the parallel second training sessions accordingly. Both of these trainings were interactive, where the volunteers asked questions for necessary clarification. In the training session on

preliminary building vulnerability assessment, the participants were introduced to the Rapid Visual Screening (RVS) survey method, the survey form with explanation of different variables and the process of data collection using “KoBo Toolbox” mobile application. At the end of the training, the volunteers were divided into nine groups to carry out the survey. Among these nine groups, three worked for data collection in the study area (Ward No. 14, Tangail Pourashava). In the training session on household questionnaire survey, the participants were introduced to the survey method, the questionnaire with explanation of different variables and the process of data collection using “KoBo Toolbox” mobile application. At the end of the training, the volunteers were divided into nine groups to carry out the survey. Among these nine groups, three worked for data collection in the study area (Ward No. 14, Tangail Pourashava).

After the second session, the third session was started which was also separate and parallel. It was an interactive session about operating demo preliminary building vulnerability assessment and household questionnaire survey in the field. For demo preliminary building vulnerability assessment survey through RVS method, the volunteers were taken to sample buildings and a hand on demonstration of the survey was conducted. For demo household questionnaire survey, the volunteers were asked to carry out the questionnaire survey to one another to have clear understanding of the survey and different variables. Later demo household questionnaire survey was conducted in a few households of the study area.

3.5.7 Primary Data Collection for Detailed Vulnerability Assessment of Buildings: Details Engineering Assessment (DEA)

Based on the preliminary building vulnerability assessment and as per requirement for contingency planning, some buildings will be selected in the study area for Details Engineering Assessment (DEA). For this purpose, some destructive and non-destructive test and measurements will be taken in the buildings for checking design requirements of the BNBC. They are:

- a) Ten (10) boreholes up to 100 ft. the depth and undisturbed soil samples will be collected and Microtremor tests will be done.
- b) Detail dimensions (dimension of the buildings, room, kitchen, toilets, door, windows, and floor to floor height etc.) will be collected.

- c) Ferroscan tests will be performed. At the same time, cores from the column will be collected.
- d) Footings excavation will be executed and direct shear test of masonry buildings will be performed.

3.6 Assessment of Seismic Exposure

The collected borehole data and undisturbed soil samples were analyzed and plotted to understand the seismic exposure of the study area. Microtremor test data were analyzed and plotted to know dynamic characteristics of soil in the study area.

3.7 Building Vulnerability Assessment

3.7.1 Preliminary Assessment: RVS Method

Based on collected data, a score for each of the buildings surveyed was calculated following methods of RVS. It indicates the seismic performance of the buildings. The scores are based on the probability of building collapse and average expected ground shaking levels for the seismicity region (FEMA, 2015). A cut-off score is suggested based on the present seismic design criteria. If the building's score is less than the cut-off score, the buildings should be investigated by a design professional experienced in seismic design. If a building receives a score higher than cut-off score, the building is considered to have adequate seismic resistance to prevent collapse during a rare earthquake. The score is not meant to be an indicator of the probability that the building will be usable following an earthquake (FEMA, 2015). Seismic evaluation and retrofit of existing buildings will be most appropriate for those buildings that require a detailed structural evaluation. In this research 1.2 is considered as the cutoff score.

3.7.2 Detailed Engineering Assessment (DEA)

The borehole test data and undisturbed soil samples will be tested in the laboratory to know the site characteristics of the selected buildings. Microtremor test data will be analyzed to know dynamic characteristics of soil beneath the buildings. Based on the collected detail dimensions of the selected buildings, their as-built drawings will be prepared. From Ferroscan test, the number and size of the reinforcing bar used in column and slab will be determined. Analyzing the cores collected from the column of the selected buildings, the compressive strength of the used concrete will be

estimated. On the basis of footings excavation, the foundation size/dimension and condition of the footing of the buildings will be determined. Additionally, based on a direct shear test of masonry buildings, lateral strength of the brick used in the buildings will be determined. Finally, Finite Element Analysis (FEA) through computer modeling will be performed and the results will be compared with the collected data. This computer modeling confirms whether the buildings are good enough to withstand gravity and seismic load or strengthening (retrofitting) is required.

3.8 Social Vulnerability Assessment

After the completion of questionnaire survey, data were exported from Kobo Toolbox as an excel spreadsheet. Total 255 household questionnaires were found for the study area which is more than the fixed sample because of covering the missed number of samples in Ward No. 14 of Tangail Pourashava. Necessary analyses were performed on the basis of the data from these 255 households. The socio-economic issues include issues like age, sex, educational level, occupation, household income, physically or mentally challenged people, house ownership etc. and the perception of the households regarding earthquake were analyzed here. Statistical analysis was performed to understand the socio-economic context of the study area. Further analysis will be carried out for social vulnerability assessment in the study area.

3.9 Contingency Planning for Earthquake

Based on building and social vulnerability of the study area, an earthquake contingency plan is expected to be prepared for the study area. The contingency plan would have four components. They are:

- Temporary Shelter Planning
- Emergency Health Facility Planning
- Evacuation Route Planning
- Identification of space for Ward Co-ordination Center

3.9.1 Temporary Shelter Planning

After an earthquake, it is expected that good number of people will be homeless due to collapse of buildings. It would be an urgent need to provide them shelter.

Temporary dwellings constitute a crucial step of recovery and reconstruction in the post-disaster aftermath. It plays a vital role in order to provide protection to the affected people and provide a habitable environment while the outcomes of a disaster are being evaluated and then rectified (Donohue, 2012). Different steps of temporary shelter planning are discussed here:

a) Need Assessment (Demand Calculation for Disaster Shelter)

In this research it has been assumed that the people residing in vulnerable buildings with probability of extensive or complete structural damage after an earthquake would require disaster shelter in the study area. Considering the assumption, firstly the vulnerable residential and mixed use (with residential use) buildings in the study area with probability of extensive or complete structural damage were estimated accordingly. From section “3.5.3 Primary Data Collection for Preliminary Vulnerability Assessment of Buildings: Rapid Visual Screening (RVS) Method” it can be observed that sample number of buildings in the study area have been assessed for building vulnerability. Now demand estimation based on scenario of the sample buildings would underestimate the demand scenario. Again, the sample size represents the population at 95% confidence level and 5% confidence interval. Therefore, the scenario of extensive or complete structural damage of sample residential and mixed use (with residential use) buildings were translated into the total residential and mixed use (with residential use) buildings in the study area proportionally with respect to number of storey of the buildings. In this way number of vulnerable residential and mixed use (with residential use) buildings with probability of extensive or complete structural damage after an earthquake in the study area were estimated with respect to number of storey.

After the identification of the vulnerable residential and mixed use (with residential use) buildings it was necessary to estimate the number of people residing in these buildings. The data on building wise occupancy were unavailable. So, occupancy per residential floor was estimated in this research. While doing so it was found that population of the study area was available for the year 2011 from BBS (BBS, 2011). But from 2011 to 2020 the study area went through significant growth. Therefore, the population of the area was projected for 2020 based on population and growth factor from BBS (BBS, 2011). Then total number of residential floors in the study area was

estimated from all residential buildings and their corresponding number of storey, and residential floors in mixed use buildings. From total number of residential floors and total population in the study area, number of people residing per floor was estimated. Using this occupancy per floor, number of people residing in the identified vulnerable residential and mixed use (with residential use) buildings in the study area were calculated. Among them, people requiring disaster shelter were estimated based on the assumptions as per HAZUS technical manual (FEMA, 2012). The assumptions considered in this research for disaster shelter demand calculation is shown in Table 3.5. Equation 1, 2 and 3 show the formulas for disaster shelter demand estimation in the study area.

Table 3.5 : Assumption for disaster shelter demand calculation

Probable damage state of vulnerable residential buildings	Factor
Buildings with probability of extensive structural damage (F_e)	0.9
Buildings with probability of complete structural damage (F_c)	1.0

Source: Adapted from FEMA (2012)

$$D_e = \sum B_e \times n \times p \times F_e \dots \dots \dots \text{ (Equation 1)}$$

Here,

D_e = Number of people requiring disaster shelter residing in vulnerable buildings with probability of extensive structural damage

B_e = Number of vulnerable buildings with probability of extensive structural damage

n = Number of residential floors in the corresponding buildings

p = Population per residential floor

F_e = Factor of disaster shelter requirement for vulnerable buildings with probability of extensive structural damage

$$D_c = \sum B_c \times n \times p \times F_c \dots \dots \dots \text{ (Equation 2)}$$

Here,

D_c = Number of people requiring disaster shelter residing in vulnerable buildings with probability of complete structural damage

B_c = Number of vulnerable buildings with probability of complete structural damage

n = Number of residential floors in the corresponding buildings

P = Population per residential floor

F_e = Factor of disaster shelter requirement for vulnerable buildings with probability of extensive structural damage

$$D = D_e + D_c \dots \dots \dots \quad (\text{Equation 3})$$

Here,

D = Total number of people requiring disaster shelter

D_e = Number of people requiring disaster shelter residing in vulnerable buildings with probability of extensive structural damage

D_c = Number of people requiring disaster shelter residing in vulnerable buildings with probability of complete structural damage

b) Available Space Assessment (Supply Calculation)

In Japan, large-park or open space, playground, religious and school buildings and spaces in public buildings are considered to provide shelter in after math of an earthquake (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012) while after 2015 tents in open spaces were used in Nepal as temporary shelter (Sheltercluster.org, 2018) (Figure 3.8). So for temporary shelter, open space, playground, religious and educational buildings and spaces in public building used for community facilities were considered.



(a) At the Ofunato Junior High School, Japan



(b) At Army ground in Kathmandu, Nepal

Figure 3.8: Example of temporary shelter

Thus, all the possible temporary shelters (open space; educational/ religious institution and public building used for community facility) in the study area were identified. Here mixed use buildings were left out from consideration due to their unsuitability. The institutional buildings to be used for temporary shelter should be structurally safe. Therefore, the buildings, which deemed to be structurally unsafe according to the RVS score, were identified. In this regard, buildings with RVS score below 1.2 was considered as unsafe or vulnerable to earthquake. Estimation of space

in safe and unsafe structures were done separately. This would bring out the scenario about the unsafe institutional buildings that would be made available for temporary shelter if these buildings could be retrofitted accordingly.

Now, the whole area of open spaces and total floor area of building would not be usable for functional for shelter purpose. Thus, functional spaces for shelter purpose in the selected temporary shelters were calculated. For this purpose, it was assumed that 80% of the available space would be used as shelter. The rest of the 20% space would be used for supporting facilities and activities, e.g. toilet, bathroom, kitchen, registration area, circulation, etc. In this way, available area of open spaces was calculated and available floor space of the public buildings (educational/ religious institution and public building used for community facility) were found. It was assumed that a person needs 1.8 m^2 of space in temporary shelter (Sphere Project, 2011; Xu, Okada, Hatayama, & He, 2006). Accordingly, number of persons that can be accommodated in the selected temporary shelters were calculated for safe and unsafe facilities separately.

c) Demand Supply Comparison

After the calculation, the demand for temporary shelter and supply of safe temporary shelter have been compared to understand surplus or deficit of temporary shelter in the study area. Additionally, potential of the institutional buildings (now unsafe) which can be used as temporary shelter if retrofitted was also analyzed to cover the deficit (if occur) or to support surrounding areas.

d) Finalization of Selection and Estimation through Workshop

In future a workshop will be arranged in the study area where the demand, safe temporary shelters, demand supply comparison, and the potential to allocate homeless people in institutional buildings (now unsafe) which can be used as temporary shelter if retrofitted will be presented to the local people. Here the local participants will assess the potentials of these places of temporary shelters. Based on their feedback, final selection and estimation of the temporary shelters will be done.

e) Estimation of Supporting Facilities in Selected Temporary Shelters

Temporary shelters need to meet the need of the people staying in the shelters after an earthquake. So there is need for toilet, water and first aid treatment facility etc.

After final selection of the temporary shelters, the need for supporting facilities will also be estimated considering their capacity (Sphere Project, 2011).

Table 3.6: Assumptions for estimating facilities in temporary shelters

Facility/ Amenity	Standard
Toilet	1 per 50 persons
Water	15 liters 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)

3.9.2 Emergency Health Facility Planning

The collapse of structural buildings due to earthquake may result in death and severe injury to the people of the study area. Emergency health facilities will be required to minimize the sufferings of the injured people after an earthquake. The steps for emergency health facility planning in the study area are discussed in the following sections.

a) Need Assessment (Demand Calculation for Emergency Health Facility)

After an earthquake, people may be injured at different severity level requiring different level of medical facility accordingly. Table 3.7 shows different severity level of injury after an earthquake with corresponding description of the injury level and treatment requirement. From the Table it can be observed that people with severity level two and three would require emergency health facility. Level one injury can be treated by first aid and severity level four injury would require specialized facilities in regional health facility. Therefore, the target group for the emergency health facilities in the study area would be decided based on injury level. That means people with severe injury would be given priority for emergency health facility.

Table 3.7: Different severity level of injury after an earthquake

Severity level of injury	Description of the injury	Treatment requirement
Severity 1	Some examples are: a sprain, a severe cut requiring stitches, a minor burn (first degree or second degree on a small part of the body), or a bump on the head without loss of consciousness.	First aid treatment at disaster shelters: Require basic medical aid that could be administered by paraprofessionals or persons with first aid training. These types of injuries would require bandages or observation.
Severity 2	Some examples are third degree burns or second degree burns over large parts of the body, a bump on the head that causes loss of consciousness, fractured bone, dehydration or exposure.	Emergency health facility: Require 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.
Severity 3	Some examples are: uncontrolled bleeding, punctured organ, other internal injuries, spinal column injuries, or crush syndrome.	Emergency health facility: Injuries that pose an immediate life threatening condition if not treated adequately and expeditiously.
Severity 4	Instantaneously killed or mortally injured	Regional health facility.

Source: Adapted from FEMA (2012)

In this research it has been assumed that the people occupying in vulnerable buildings with probability of extensive or complete structural damage after an earthquake would be injured in the study area requiring emergency health facility. Considering the assumption, firstly the vulnerable buildings in the study area with probability of extensive or complete structural damage were estimated accordingly. From section “3.5.3 Primary Data Collection for Preliminary Vulnerability Assessment of Buildings: Rapid Visual Screening (RVS) Method” it can be observed

that sample number of buildings in the study area have been assessed for building vulnerability. Now demand estimation based on scenario of the sample buildings would underestimate the demand scenario. Again, the sample size represents the population at 95% confidence level and 5% confidence interval. Therefore, the scenario of extensive or complete structural damage of sample buildings were translated into the total buildings in the study area proportionally with respect to structure type and number of storey of the buildings. Now, structure type of all the buildings were also missing in the database. So proportion of structure types found from sample buildings were considered to be representative of total buildings. In this way number of vulnerable buildings with probability of extensive or complete structural damage after an earthquake in the study area were estimated with respect to structure type and number of storey.

After the identification of the vulnerable buildings it was necessary to estimate the number of people occupying in these buildings. The data on building wise occupancy were unavailable. So, occupancy per floor was estimated in this research. While doing so it was found that population of the study area was available for the year 2011 from BBS (BBS, 2011). But from 2011 to 2020 the study area went through significant growth. Therefore, the population of the area was projected for 2020 based on population and growth factor from BBS (BBS, 2011). Then total number of floors in the study area was estimated from all buildings and their corresponding number of storey. From total population and total number of floors in the buildings in the study area, gross number of people occupying per floor was estimated. Using this occupancy per floor, number of people occupying in the identified vulnerable buildings (with respect to structure type) with probability of extensive or complete structural damage were estimated accordingly in the study area. Among them, people requiring disaster shelter were estimated based on the assumptions as per HAZUS technical manual (FEMA, 2012). Here only the surveyed buildings have been considered for injury estimation. The assumptions considered in this research for calculation of injury with respect to severity level is shown in Table 3.8. Equation 4, 5, 6 and 7 show the formulas for injury estimation in the study area at different severity level.

Table 3.8: Assumption for calculation of injury

Probable damage state of vulnerable buildings	Severity level of injury (% of people residing in the building)			
	Severity 1	Severity 2	Severity 3	Severity 4
Extensive Structural Damage (all structure type except URM)	1	0.1	0.001	0.001
Extensive Structural Damage (URM structure type)	2	0.2	0.002	0.002
Complete Structural Damage With Collapse (all structure type)	40	20	5	10

Source: Adapted from FEMA (2012)

$$I_{ie} = \sum B_e \times n \times p \times F_{ie} \dots \dots \dots \quad (Equation 4)$$

Here,

I_{ie} = Number of injured people at severity level ‘i’ occupying in vulnerable buildings with probability of extensive structural damage (all structure type except URM)

B_e = Number of vulnerable buildings with probability of extensive structural damage (all structure type except URM)

n = Number of floors in the corresponding buildings

p = Occupancy per floor

F_{ie} = Percentage of people injured at severity level ‘i’ in vulnerable buildings with probability of extensive structural damage (all structure type except URM)

$$I_{ieu} = \sum B_{eu} \times n \times p \times F_{ieu} \dots \dots \dots \quad (Equation 5)$$

Here,

I_{ieu} = Number of injured people at severity level ‘i’ occupying in vulnerable buildings with probability of extensive structural damage (URM structure type)

B_{eu} = Number of vulnerable buildings with probability of extensive structural damage (URM structure type)

n = Number of floors in the corresponding buildings

p = Occupancy per floor

F_{ieu} = Percentage of people injured at severity level ‘i’ in vulnerable buildings with probability of extensive structural damage (URM structure type)

$$I_{ic} = \sum B_c \times n \times p \times F_{ic} \quad \dots$$

(Equation 6)

Here,

I_{ic} = Number of injured people at severity level ‘i’ occupying in vulnerable buildings with probability of complete structural damage (all structure type)

B_c = Number of vulnerable buildings with probability of complete structural damage (all structure type)

n = Number of floors in the corresponding buildings

p = Occupancy per floor

F_{ic} = Percentage of people injured at severity level ‘i’ in vulnerable buildings with probability of complete structural damage (all structure type)

$$I_i = I_{ie} + I_{ieu} + I_{ic} \dots$$

(Equation 7)

Here,

I_i = Total number of injured people at severity level 'i'

I_{ie} = Number of injured people at severity level 'i' occupying in vulnerable buildings with probability of extensive structural damage (all structure type except URM)

I_{ieu} = Number of injured people at severity level ‘i’ occupying in vulnerable buildings with probability of extensive structural damage (URM structure type)

I_{ic} = Number of injured people at severity level ‘i’ occupying in vulnerable buildings with probability of complete structural damage (all structure type)

b) Estimating Availability of Space for Providing Medical Support:

For emergency treatment after an earthquake, the existing hospitals, clinics, and diagnostic centers in the study area were identified. Here mixed use buildings have

also been selected considering the urgent demand at the time of emergency. The health facilities should be structurally safe. Therefore, the facilities located in the structurally safe building (with RVS score equal to or greater than 1.2) were identified as a possible emergency health facility. The unsafe buildings were also considered as potential to provide health facility after an earthquake, if retrofitted accordingly. Thus, estimation of space in safe and unsafe structures were done separately. It is ideal to consider number of beds to estimate the capacity of the health facilities to treat people. But at the time of emergency after an earthquake, number of injured people would be high and therefore these facilities will have to have additional capacity to treat the injured people. Therefore, for estimation of capacity of the selected emergency health facilities, total floor area in health facility buildings and the health facility floor areas in mixed use buildings were considered for emergency health facility. For the cases of mixed use buildings which consists of residential and health use, only one floor was considered for health facility. For the cases of mixed use buildings which consist of commercial and health use, only one floor was counted for commercial purpose and the rest for emergency health facility purposes. After calculation of floor areas in the health facilities, it was considered that the whole space would not be usable for functional for shelter purpose. Thus, functional spaces for treatment purpose in the selected emergency health facilities were calculated. For this purpose, it was assumed that 80% of the available space would be used as health facility. The rest of the 20% space would be used for supporting facilities and activities, e.g. toilet, bathroom, kitchen, registration area, circulation, etc. Again, as these facilities are continuous functional, therefore some space would be occupied at the time of emergency. Here it was assumed that 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. It was assumed that a person would need 2m^2 space in an emergency health facility (Sphere Project, 2011 & Xu, Okada, Hatayama, & He, 2006). Accordingly, number of persons that can be treated in the selected emergency health facilities were calculated for safe and unsafe facilities separately.

In this preparation of contingency plan, hospitals, clinics, and diagnostic centers in the study area have been considered for emergency health facilities and pharmacies have been considered for only first aid treatment.

c) Estimation of Support Facilities to run Medical Facilities:

As all the identified health facilities are now operating as health facility, so it is logical to assume that they have the necessary support infrastructure. However, in the aftermath of an earthquake these facilities have to support more than their designed population. So, this estimation also has to be done according to standards (Table 3.9).

Table 3.9: Assumptions for estimating facilities in health facilities

Facility	Standard
No. of Toilet	1 per 20 persons
Amount of Water	50 liters per person per day
No. of Doctor	1 for 20 patient
No. of Nurses	4 nurses with each doctor

Source: (Sphere Project, 2011)

3.9.3 Evacuation Route Planning

Evacuation route is an escape designated to a facility (temporary shelter, hospital etc.) in an emergency situation, such as a fire or earthquake (CollinsDictionary.com, 2018). Evacuation route planning is a complex process consisting of several consecutive phases. After the detection of potential disaster, it is necessary to evaluate the potential threat for specific areas and then issue an evacuation order for these areas from the vulnerable area to a safe place to provide adequate protection to the residents and others. Evacuation planning is influenced by the condition of infrastructure of the affected area to ensure the accessibility to the safer place. Following steps have been followed to determine evacuation route:

(a) Identifying Vulnerable Building:

Buildings which have an RVS score less than 1.2 have been considered as vulnerable. It is assumed that debris from the collapsed building would partially or fully block the road considering different contexts.

(b) Determining Blockage in the Road:

The height of each storey of the building was considered 10 feet.

- ***No block condition:***
 - Vulnerable URM building below four stories: These buildings will not collapse due to an earthquake. If does, then it would collapse on the site. So these buildings will not block the adjoining roads (Figure 3.9a).
 - Vulnerable RCC building below four stories: These buildings will not collapse due to an earthquake. Hence there is no chance of any road blockage in front of those buildings (Figure 3.9b).
- ***Partial block condition:***
 - Vulnerable URM building four storied or more: If the building height is at least one feet less than the width of front road, then it has been considered that the road will be partially blocked. Because there will be at least one feet space for movement of people. That means the adjacent road will not be fully blocked (Figure 3.10a).
 - Vulnerable RCC building four storied or more: First condition is that, if the building height is at least one feet less than the width of front road, then it has been considered that the road will be partially blocked. Because there will be at least one feet space for movement of people. That means the adjacent road will not be fully blocked (Figure 3.10b). Second condition is that if the building height is greater than the 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 3.10c)
- ***Full block condition:***
 - Vulnerable URM building four storied or more: If the building height is greater than or equal to the width of front road, then it will fully block the road in front of it (Figure 3.11a).
 - Vulnerable RCC building four storied or more: If the building height is greater than or equal to the width of front road, and there is either no building or semi pucca or katcha or one storied safe 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 3.11b).



(a) URM buildings (Bhuj Earthquake 2001, India (Dinodia Photos RM, 2001))



(b) RCC buildings (Bhuj Earthquakes 2001, India (Datta, 2001))

Figure 3.9: No block conditions



(a) URM buildings (Bhuj Earthquakes 2001, India (Singhania, 2016))



(b) RCC building first condition (Great Hanshin Earthquake 1995, Japan (Yamanaka, 1995))



(c) RCC building second condition (Bhuj Earthquakes 2001, India (Langenbach, 2001))

Figure 3.10: Partial block conditions



Figure 3.11: Full block conditions

(c) Accessibility of the Open Roads:

Once the blocked roads are identified the rest of the open roads will be considered based on their accessibility considering road width. The routes have been classified in seven groups:

- Routes, where the pedestrian and one-way bicycle can move i.e. road width, is less than 4 feet
- Routes, where one-way non-motorized traffic (rickshaw or van), one-way motorcycle and two-way bicycle can move i.e. road width, is 4 to 8 feet
- Routes, where two-way non-motorized traffic (rickshaw or van), two-way motorcycle and bicycle can move i.e. road width, is 8 to 12 feet
- Routes which can be used as single carriageway i.e. road width, is 12 to 25 feet.
- Routes which can be used as two-lane carriageway i.e. road width, is 25 to 40 feet.
- Routes which can be used as secondary road i.e. road width, is 40 to 60 feet.

- Routes which can be used as main/primary road i.e. road width, is greater than 60 feet.

(Government of Bangladesh, 2004; Roads & Highways Department, 2004)

(d) Identifying Evacuation Route:

The partial or full blockage on the roads have been shown in point feature using ArcGIS. Based on road blockage and accessibility, the evacuation route map will be prepared in ArcGIS. This route will be usable for the evacuees to move to the temporary shelters, to take the injured people to the health facilities and to connect the temporary shelters and the health facilities with the Ward Co-ordination Center.

3.9.4 Identification of space for Ward Co-ordination Center

Ward Co-ordination Center is required during disaster in order to ensure proper mobilization and management of personnel and necessary equipment, and supplies immediate after an earthquake. In identifying Ward Co-ordination Center following criteria will be considered

- the facility should be in a government building,
- should be structurally safe and
- should be centrally located and easily accessible

3.10 Finalization of the plan at Local Workshop

It should be mentioned here that the initial contingency plan would be revised once all data is processed. It is expected that before finalization of the plan, the draft plan will be shared with local community in a workshop. In the workshop, according to the feedback from the community, necessary changes regarding temporary shelter, health facility and evacuation route would be made. The Ward Co-ordination Center can also be changed on their suggestion as happened in Mymensingh (JIDPUS & DURP, 2018). Additionally, the participants may identify some road blocks or area which would be inaccessible during monsoon. Based on their feedback, the evacuation route plan will be finalized and some recommendations will be developed to remove the identified road blockage. It is expected that this workshop will be participated by the Honorable Mayor of Tangail Pourashava, officials from Tangail Pourashava, officials from UNDP, Ward Councilor of Ward no.14, representatives of

different groups, members of civil society, earthquake volunteers and other representatives from Ward no. 14, Tangail Pourashava.

3.11 Final Report Preparation

Once the local workshop is concluded, the final report will be prepared. The report will contain not only the result of the study with appropriate figures, maps and tables but also recommendation to reduce the vulnerability of the community.

CHAPTER 4

Contingency Plan for Earthquake in the Study Area

4.1 Introduction

In this chapter, the preliminary earthquake contingency plan prepared to reduce the seismic vulnerability of Ward No. 14 of Tangail Pourashava has been discussed. The aspects which were intended to consider are:

- Temporary shelter: A place for peoples' temporary displacement caused by a disaster (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012).
- Emergency health facility: Formal health services (hospital, clinic etc.) to treat the moderate and severely injured people after an earthquake (CDMP, 2009).
- Evacuation route: Safe routes in an area for immediate transfer of victims to safer places and shelters, take the injured to health facilities and to transfer relief to the temporary shelters and emergency health facilities after an earthquake (Argyroudis, Pitilakis & Anastasiadis, 2005).
- Ward Co-ordination Center: Central command and control facility responsible for carrying out the principles of emergency preparedness and emergency management or disaster management functions at a strategic level during an emergency, and ensuring the continuity of operation at Ward level.

4.2 Temporary Shelter Planning

Temporary shelter planning for earthquake in the study area of Ward No. 14 of Tangail Pourashava has been done by firstly, estimating demand for temporary shelter; and secondly planning temporary shelter supply to meet the estimated demand. After estimation, demand and supply of temporary shelter in the study area have been compared to understand deficiency or surplus. These findings are discussed here.

For Ward 14 of Tangail Pourashava, the demand population for temporary shelter is 5274 which means 5274 people would require temporary shelter in the scenario of structural damage due to earthquake.

It is evident from prevailing literature that large-park, playground and open space, and religious, educational and public buildings are used as temporary shelter (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012). Additionally, from household questionnaire survey, it has been found that residents of this area prefer open space, playfield, government buildings, educational facilities, socio-cultural and urban service related community facilities as temporary shelter. Thus, the open spaces and facility buildings (i.e. religious, educational institutions, socio-cultural and urban service related community facilities) have been considered to be used as temporary shelter in the study area. Figure 4.1 shows the location of possible temporary shelters in the study area including open spaces and public buildings. Among the facility buildings identified to be used for temporary shelter, some are structurally vulnerable (with RVS score less than 1.2) which cannot be utilized as temporary shelter. Figure 4.2 shows location of possible temporary shelters in the study area considering safety including the open spaces, safe public buildings and unsafe public buildings. Table 4.1 shows the supply scenario of the possible temporary shelters in the study area including supply as a whole, capacity of safe facilities and capacity of unsafe facilities.

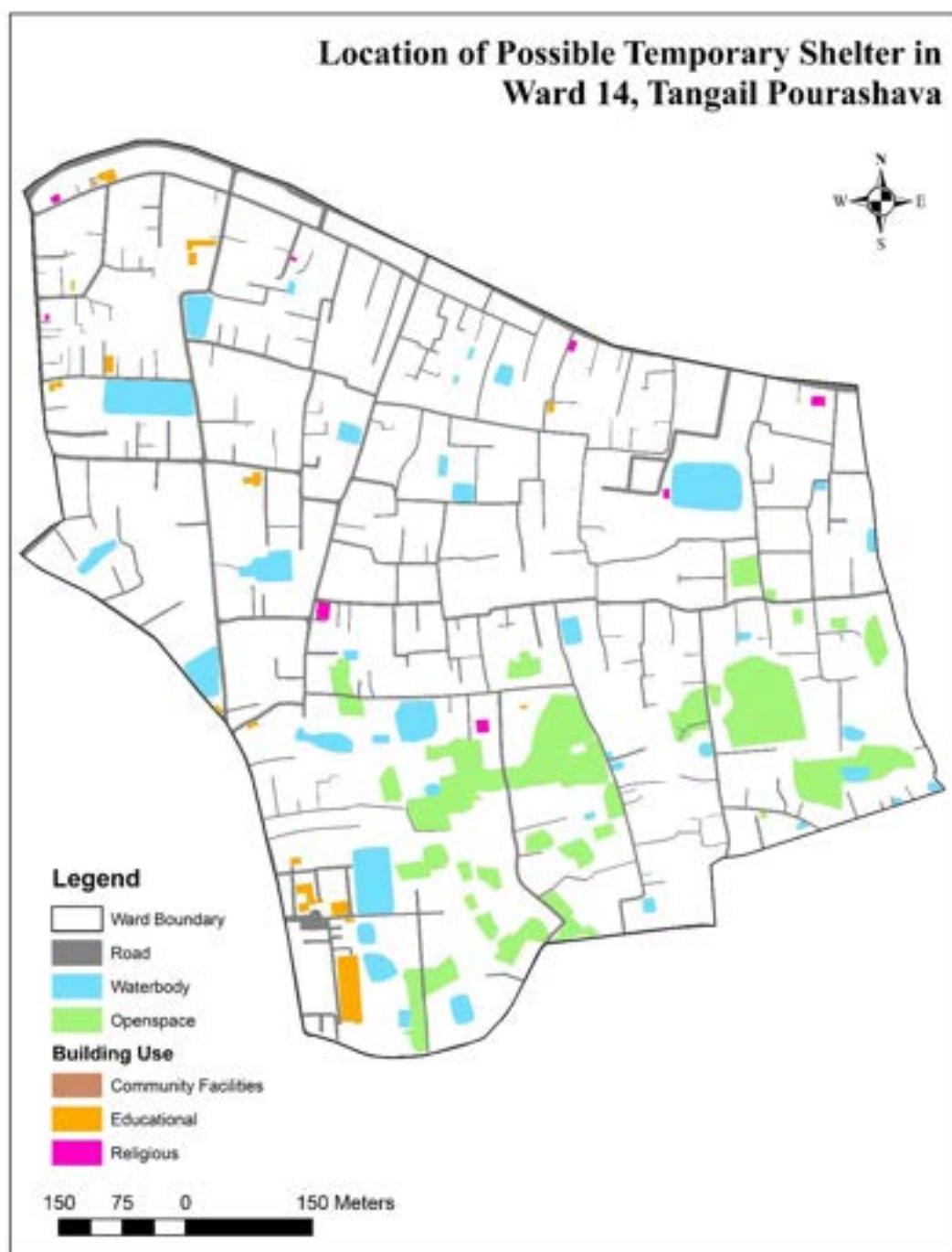


Figure 4.1: Location of possible temporary shelter in the study area

(Source: Field Survey, 2020)

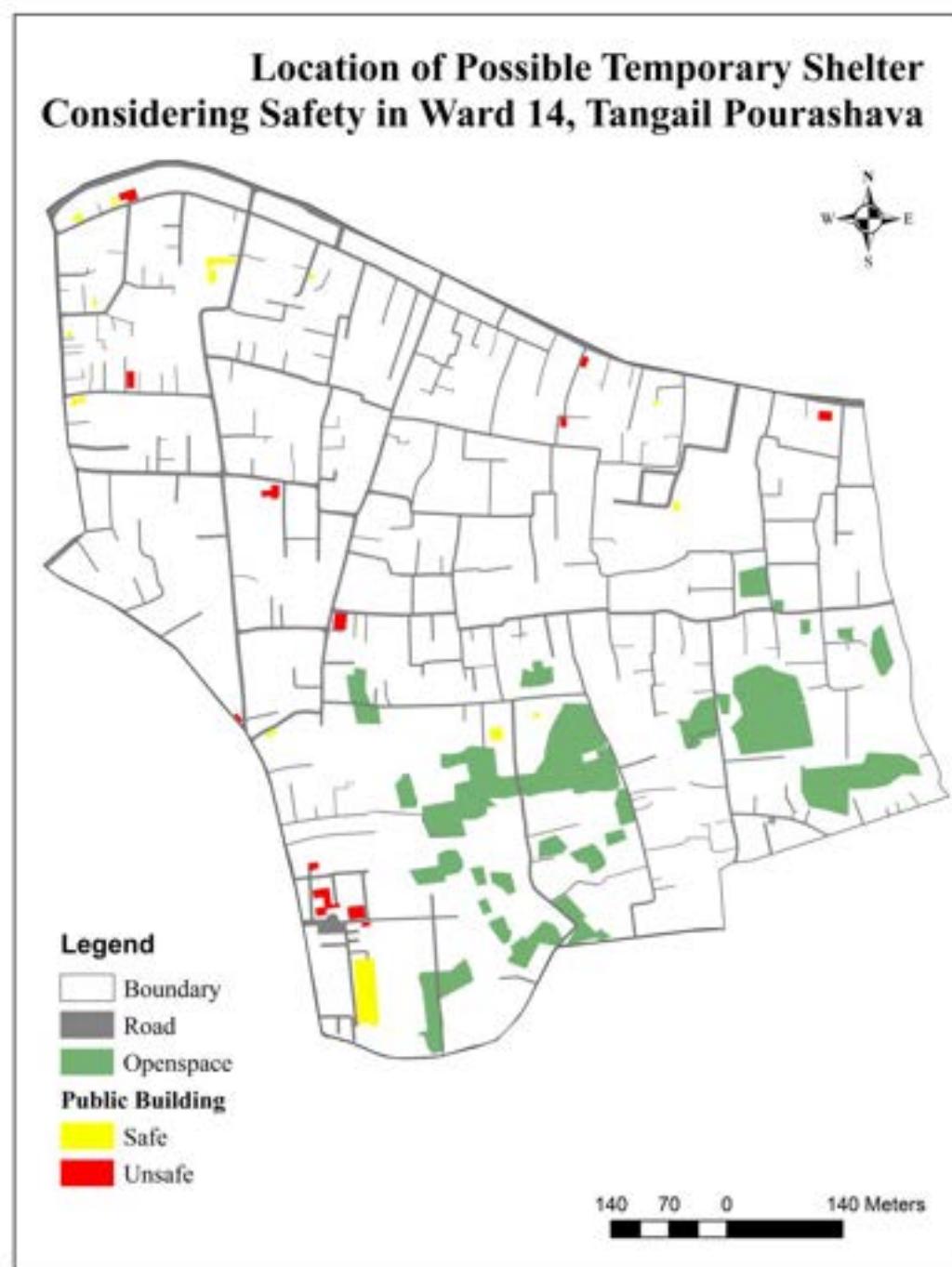


Figure 4.2: Location of possible temporary shelter in the study area considering safety
(Source: Field Survey, 2020)

Table 4.1: Supply scenario of the possible temporary shelters in the study area

Type	Total			Safe facilities			Unsafe facilities		
	Number of facilities	Area to be used for shelter purpose (sq. m.)	Capacity (no. of people)*	Number of facilities	Area to be used for shelter purpose (sq. m.)	Capacity (no. of people)*	Number of facilities	Area to be used for shelter purpose (sq. m.)	Capacity (no. of people)*
Open space	32	38884.45	21602	32	38884.45	21602	0	0	0
Educational Institution	18	7113.22	3951	8	2240.262	1244	10	4872.958	2707
Religious Institution	9	1482.522	823	5	370.531	205	4	1111.991	618
Community Facility	3	75.053	41	3	75.053	41	0	0	0
Total	62	47555.245	26417	48	41570.296	23092	14	5984.949	3325

Source: (Field Survey, 2020)

* 1.8 m² in shelter is required per person according to Sphere Project (2011)

From Figure 4.2 and Table 4.1 it can be observed that most of the public buildings with higher capacity in the study area are unsafe. Table 4.1 also shows overall capacity, capacity of safe facilities and how much more can be added if unsafe facility buildings are retrofitted. If the unsafe buildings are retrofitted they would be able to accommodate 3325 more people.

From the demand-supply comparison, it has been found that the supply of temporary shelter in safe facilities is sufficient to accommodate the people requiring disaster shelter. Though the unsafe temporary shelters are not required to fulfill the demand, retrofitting of these buildings can prevent structural damage and other losses. Additionally, these facilities can support by accommodating homeless people from surrounding areas.

It needs to be noted that final selection of temporary shelters will depend on willingness of the owner of the facilities, floor plan of the structure, difficulty of converting the building to temporary shelter during need etc. In case of open space, weather condition (dry and wet seasons) is another important criteria. Moreover, due to road blockage, some of the identified temporary shelter may remain inaccessible at the event of an emergency. In future these issues will be discussed with the stakeholders during consultation workshops to finalize the selection of temporary shelters.

4.3 Emergency Health Facility Planning

A considerable number of people would be injured in an earthquake. Considering the assumptions mentioned in Chapter 3, a possible number of injured people in the study area have been calculated corresponding to different severity level which is shown in Table 4.2.

Among the probably injured persons, Severity 1 can be treated in pharmacies or by primary treatment experts in a temporary shelter without getting admitted to hospital. But the people with higher level injury (Severity 2 and Severity 3) need treatment from experts in health facilities. Injured people of Severity 4 will be instantaneously killed or mortally injured, for whom further expertise treatments will be required. Thus total 954 injured people (Severity 2, 3 and 4) will be required to be admitted to the health facilities.

Table 4.2: Need of emergency health facilities in the study area

Total Popⁿ	Injured people: Severity 1	Injured people: Severity 2	Injured people: Severity 3	Injured people: Severity 4
13729	1113	546	136	272

(Source: Calculation based on Field Survey, 2020)

The emergency health facilities were identified as per the requirement mentioned in Chapter 3. Figure: 4.3 shows locations of possible emergency health facilities in the study which includes hospital, diagnostic center and clinics and pharmacies might be used for giving first aid treatment for injured people of severity 1. These facilities actually are not concentrated in a certain location. Capacity of the health facilities are calculated here for two scenarios. First, there has been considered only structurally safe health facility buildings. In second, structurally unsafe health facility buildings were taken into account. If only safe buildings could not meet the demand, then selected unsafe health facility buildings might be retrofitted to equalize the supply and demand. Figure: 4.4 shows the emergency health facility buildings according to the structural safety of the facility building.

Considering the assumptions described in methodology chapter (Chapter 3: 3.9.2), the capacity of each of the emergency health facilities were determined

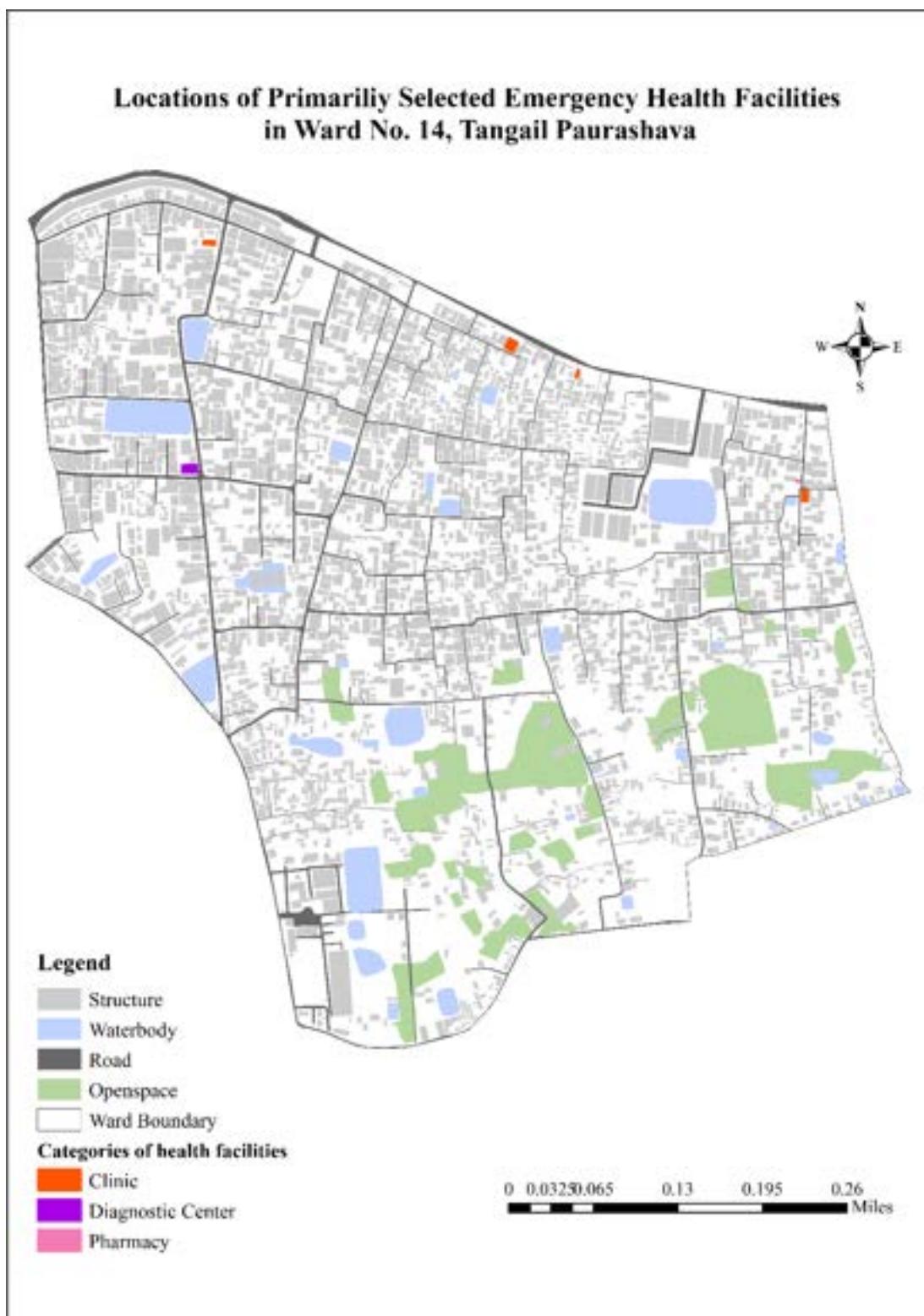


Figure 4.3: Location of possible emergency health facilities in the study area

(Source: Field Survey, 2020)



Figure 4.4: Location of possible emergency health facilities in the study area considering safety

(Source: Field Survey, 2020)

Table 4.3: Supply scenario of the possible emergency health facilities in the study area

Type	Total			Safe facilities			Unsafe facilities		
	Number of facilities	Available space to be used for health facility (sq. m.)	Capacity (no. of people)*	Number of facilities	Available space to be used for health facility (sq. m.)	Capacity (no. of people)*	Number of facilities	Available space to be used for health facility (sq. m.)	Capacity (no. of people)*
Hospital	0	0	0	0	0	0	0	0	0
Clinic	4	157.61	77	3	88.12	11	1	69.48	34
Diagnostic Centre	1	82.032	41	0	0	0	1	82.03	41
Total	5	239.64	118	3	88.12	43	2	525.62	75

Source: Field Survey, 2020

* 2 m² in shelter is required per person according to Sphere Project (2011)

which has been shown in Table 4.3. It also shows number of emergency health facilities and their area and the number of persons they could treat considering the space requirement per person (2 square meters) for both safe and unsafe facility buildings.

It has been found from Table 4.3 that that only 43 people can be given treatment in the structurally safe emergency health facilities. If the unsafe building could be retrofitted 75 people more could have been given health service at the time of emergency.

Comparing the probable requirement (Table 4.2) and availability (Table 4.3) it can be concluded that there are not enough facilities within the study area to treat the estimated injured persons even if the unsafe health facilities are retrofitted. New health facilities for the emergency use of earthquake have to be managed in the study area. Table 4.4 shows the situation between requirement and availability of emergency health facilities in Ward No. 14.

Table 4.4: Demand-supply comparison of emergency health facilities in the study area

Demand-supply components	Number of people	Surplus/ Deficit
Person needed to be treated	954	-
Person can be treated in safe facilities	43	-911
Person can be treated if unsafe facilities are retrofitted and added	118	-831
Remarks	Primarily available space for emergency health facilities is not sufficient and additional space is required.	

(Source: Calculation based on Field Survey, 2020)

It must be remembered that final selection of emergency health facility will depend on the structural vulnerability of the facility buildings considered to be used for emergency health facility. Moreover, due to road blockage, some of the identified emergency health facility may remain inaccessible at the event of an emergency. These conditions will lead to exclusion of some possible emergency health facility. In future these issues will be discussed with the stakeholders during consultation workshops to finalize the selection of emergency health facilities.

4.4 Evacuation Route Plan

Figure 4.5 shows the existing accessibility condition within Ward 14 of Tangail Pourashava. The northern and western sides of ward boundary are merged with two lane carriageway and single carriageway respectively accessible by the motor vehicles. The northern boundary side road is Dhaka-Tangail Road. Among the three selected wards of Tangail, ward 14 does not seem to be in good accessibility condition, as the internal roads are not single carriageway (12 to 25 feet) in most of the cases. Rather the internal road network of ward 14 is not that kind of good in terms of road width. Most of the roads belong to the category of ‘<4 feet’ and ‘4-8 feet’ which are accessible by pedestrians and one-way bicycle; and one-way non-motorized traffic (rickshaw or van), one-way motorcycle and two-way bicycle respectively. A number of roads are also found with the width of 8 to 12 feet. The internal road network is more concentrated in the northern part than the southern part of the ward.

Figure 4.6 identifies the location of probable blockage (full and partial blockage) if an earthquake strikes based on the assumptions described in methodology. Accessibility of the roads for rescue and rehabilitation can be identified considering the road width and blockage size after an earthquake from this map. It can be observed from the map that most of the blockages will be found in the north-western portion of the ward. Roads in this portion will become inaccessible because of these blocks. Blockages are less concentrated in the north-eastern part of the ward and almost no blockage is found in the southern part. Full blockages are found higher in amount than partial blockages. Map also shows that roads with lower road width will be inaccessible mostly due to blockage. On the other hand, roads like single carriageway or two lane carriageway will not be that much affected by blockage.

It can be assumed that rescuing from residential building and access to temporary shelter and emergency health facility will be quite challenging because most of the access roads of the residential buildings will be fully blocked. These blockage of roads are crucial as they will trap other roads which will be unable to use for any kind of movements and which will possibly prohibit entrance of any large emergency vehicle or rescuing equipment in the north-western portion of the ward.



Figure 4.5: Road width and accessibility condition

(Source: Based on Tangail Pourashava, 2010 updated by Field Survey, 2020)

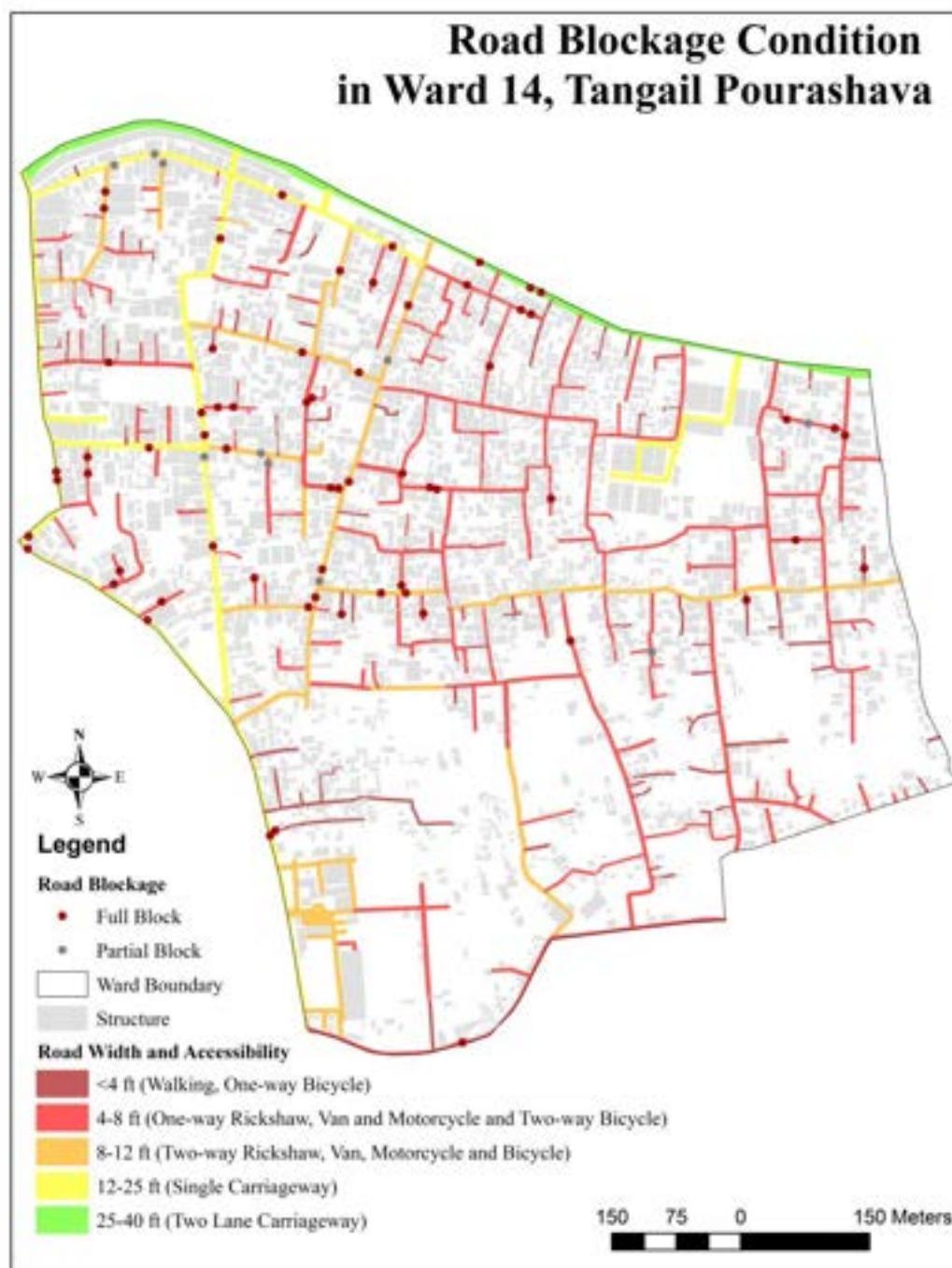


Figure 4.6: Road blockage condition

(Source: Field Survey, 2020)

4.5 Ward Co-ordination Center

One of the important tasks during and after any disaster is to coordinate the different activities of management. Tasks performed by different government agencies, private organizations, volunteers, and individuals are needed to be coordinated to get the maximum benefit. In addition, WDMC needed a place to coordinate the works. For this co-ordination, Ward Co-ordination Center (WCC) is proposed to be formed in the study area. In the following sections, proposed location and institutional setup for Ward Co-ordination Center are described. Among the safe public buildings, one will be used as Ward Co-ordination Center. As mentioned earlier, the research team is still working on building vulnerability data as well as to identify the exact location of Co-ordination center the discussion with local people and stakeholders are necessary, so selection of the building to be used for WCC is under process. Moreover, final vetting of the contingency plan will be done in consultation with local people.

4.5.1 Institutional Setup and Management Activities

Figure 4.7 shows the structure of Ward Co-ordination Center Committee. Each team should contain two team leaders, but to manage the process properly each team will require more team members.

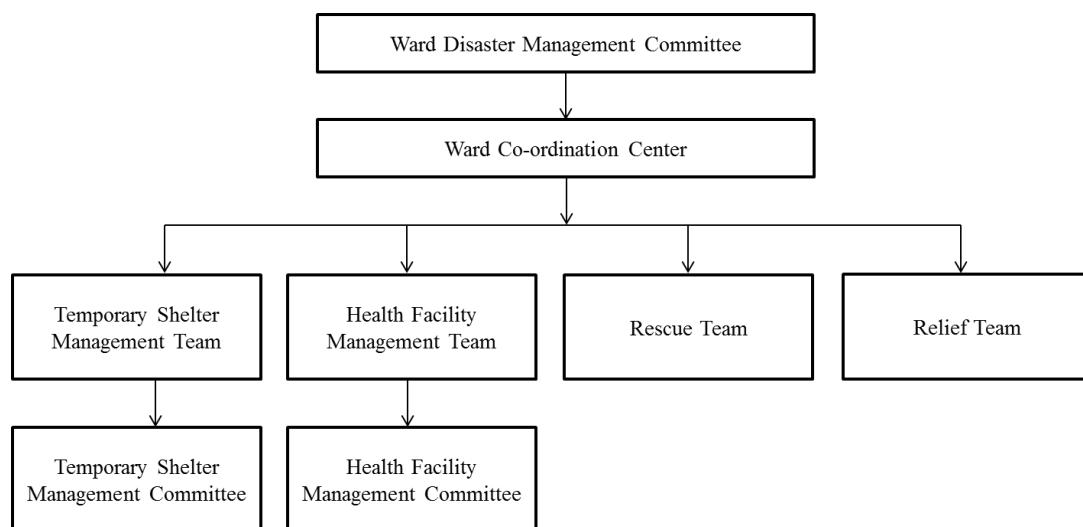


Figure 4.7: Structure of Ward Co-ordination Center Committee

All the members of the committee should meet once in three months to keep update about the responsibilities and should keep a link with the WDMC, TSMC, and EHFMC.

The committee consists of the following teams.

Temporary Shelter Management Team: Co-ordinate with all the TSMC.

Health Facility Management Team: Co-ordinate with all the EHFMC.

Rescue team: To take part in the rescue operation

Relief team: To collect, manage and distribute reliefs in temporary shelters and emergency health facilities

4.5.2 Criteria for Selecting Members

All the members of the committee should be residents of the area i.e. Ward No 14 and representatives from all the clusters should be ensured. Each member should be familiar with the area. A representative from the bureaucracy of Tangail Pourashava should also be the member of the committee. This will increase credibility and effectiveness of the committee. It is also desirable that at least one member of the owners of these private medical facilities should be co-opted in the health facility management team under this committee. The BUET team suggests there should be at least three members from the private medical facilities representing hospitals, clinics, and diagnostic centers accordingly. The members and others involved in the committee should be properly trained and their activities and responsibilities at different phases of disaster will be assigned. The assigned members should keep contact with TSMC and EHFMC, other agencies and institutions

4.5.3 Activities of Ward Co-ordination Center Committee at Different Phases of an Earthquake

To be prepared, the committees have to regularly meet and perform task before the disaster. Similarly they have some task during and after the disaster. The following provide a tentative list of task the committees would perform.

a) Activities before Disaster

- A systematic program for the inspection, maintenance, and repair of buildings identified as temporary shelters and emergency health facilities at regular interval at the community level by building maintenance and rehabilitation team
- Storage of equipment and emergency supplies
- Proper dissemination of the prepared plans at the community level by victim registration and information team

- The training program at community level at a regular interval
- The arrangement of community awareness program at a regular interval such as disaster drills, emergency training, community meetings etc.

- Preparation of volunteer list at the community level and updated it at regular interval
- Distribution of activities of volunteers
- Training of volunteers based on their activities

b) Activities within 72 Hours of an Earthquake Event

- Evacuation of the people to the predefined evacuation space.
 - The arrangement of necessary reliefs by the relief management team.
 - Search and rescue of people by the search and rescue team.
 - Disaster victim registration and segmentation of the victims according to their need for health facility and shelter requirement.
 - Assessment of the suitability of the pre-identified temporary shelters and emergency health services by building maintenance and rehabilitation team. If any of the pre-identified temporary shelters and emergency health services are proved to be unsuitable, then initiative should be taken to identify alternative places to provide temporary shelter and emergency health facility.
 - Assessment of the pre-identified evacuation routes (to reach the shelters and health services) to find out whether they are open or not. If required, new evacuation routes should be identified or adjustments should be done. The routes that must be opened to support health, shelter and relief operation should be given priority while clearing debris.
 - The arrangement of the identified shelters with designated TSMC according to the plan for receiving people.
 - Preparation of the designated emergency health facilities with designated EHFMC along with all the doctors and nurses to serve the injured people.
 - The arrangement of inventory and equipment supply at Ward Co-ordination Center.
- c) Activities from 72 Hours to 14 Days of an Earthquake Event**
- Continue search and rescue operation

- Continue disaster victim registration
- Initiation of temporary shelter operation. The victims should be brought from the evacuation space and directly from the rescue spot to a temporary shelter. Necessary first aid should be provided to the injured people. The designated shelter management team should manage the shelter along with the help of the evacuees. Need for supplies and equipment should be estimated properly.
- Provide treatment to the injured people accordingly in the designated emergency health facilities.
- Collection of reliefs assigned to the community by the relief team from government agencies, NGOs, international organizations etc. From the center, reliefs should be distributed to the temporary shelters and the emergency health facilities according to the requirement. In the center, there should be food preparation facility. Here food for the victims should be prepared, where food preparation standards should be observed. The prepared food should be disseminated in nearby shelters and health facilities as required.
- Establishment of necessary extra emergency setups
- It will not be possible to construct permanent houses immediately. So, initiatives to construct transition shelters should be taken.

d) Activities from 14 Days to 60 Days of an Earthquake Event

- Full shelter capability should be maintained.
- The facilities of emergency health facilities should be continued.
- Relief management should be continued
- Construction of transition shelter should be initiated and completed
- Transfer of victims from temporary shelter to transition shelters or the repaired residential houses should be initiated.

e) Activities from 60 Days to One Year of an Earthquake Event

- The transfer of victims from temporary shelter to transition shelters or the repaired residential houses should be completed.
- The temporary shelters should be closed and the regular activities should be started.

- The construction work of permanent shelters should be started. The shelters should be allocated on land where the beneficiaries lived before the earthquake, promoting the return of displaced people to their places of origin. The transition of families to permanent housing should be initiated (Xu, Okada, Hatayama, & He, 2006).

CHAPTER 5

Conclusion

It should be bear in mind that contingency plan is neither a stand-alone document nor a static document. It should be an ongoing process integrated and coordinated with activities suggested by other documents. It is well understood that earthquake would cause damaged at regional scale. So, contingency plan at regional scale should be prepared. But the issue which bears the highest importance is to count the effect of an earthquake on spatial dimension at local level. Though CDMP (2014) prepared a contingency plan for Tangail Pourashava, importance was given on institutional activities and less focus on local level panning. Though the work on this ward is not completed yet, involvement of local level planning and community participation will be ensured in the next stages. However, for successful implementation of the contingency plan, this kind of plan needed to be prepared for the other wards of the Pourashava.

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APPENDIX A

Clusters of Ward 14, Tangail Pourashava

Ward 14- Tangail Sadar

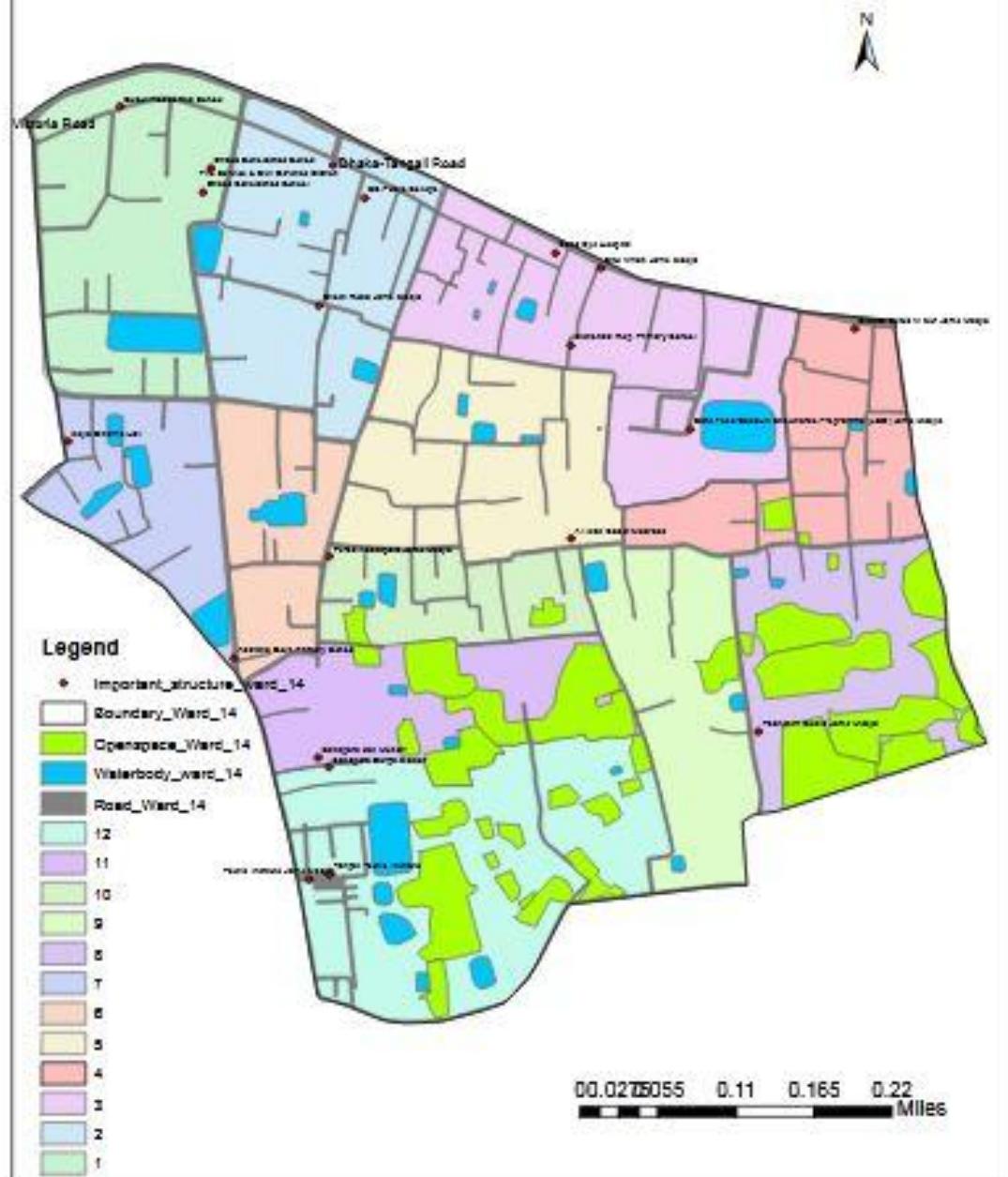


Figure: Map showing clusters of Ward 14, Tangail Pourashava

APPENDIX B

Checklist for Physical Observation Survey

Checklist for Data Updating: Physical Observation Survey

1. Ward No
 2. Building ID
 3. Holding No
 4. Type of the structure
 1. Pucca
 2. Semi-pucca
 3. Katcha
 5. Number of storey
 6. Building use
 1. Residential
 2. Commercial
 3. Industrial
 4. Educational
 5. Community facilities
 6. Health
 7. Administrative
 6. Religious
 7. Others
- If “Educational”, please specify the type _____
- If “Health”, please specify the type _____
- If “Religious”, please specify the type _____
- If “administrative”, please specify the type _____
- If “community facilities”, please specify the type _____
7. Width of adjacent road (in feet)

APPENDIX C

Checklist for Rapid Visual Screening (RVS)

Checklist for Rapid Visual Screening (RVS)

Ward Number

- 13
- 14
- 16

1. Building ID

2. Occupancy (ভবনের ব্যবহার)

Please look for the question at the supporting document

- Assembly
- Commercial
- Residential
- Industrial
- Office
- School
- Utility
- Warehouse
- Emergency Service

2.1 Total No. of Units

(if residential)

3. Ownership of the building (ভবনের মালিকানা)

- Public
- Private

4.1 No. of Story (ভবনে তলার সংখ্যা)

(Above Grade)

4.2 No. of Story (ভবনে তলার সংখ্যা)

(Below Grade) (if not type 0)

5. Floor Area (ভবনের ক্ষেত্রফল)

Approximate in ft. square

6. Building Type (ভবনের প্রকৃতি)

Please look for the question at supporting document

- C2 - Concrete Shear Wall Building
- C3 - Concrete Frame With Masonry Infill Walls
- URM - Unreinforced Masonry Building
- S1 - Steel Moment Resistant Frame
- S2 - Braced Steel Frame
- S3 - Light Metal Building
- S5 - Steel Frame With Unreinforced Masonry Infill Wall
- W1 - Wood Light Frame
- W1A - Multi-Storey Multi-Unit Residential (Plan Area > 3000 sq. ft)
- W2 – Wood Frame Commercial & Industrial (Plan Area > 5000 sq. ft)

7. Severe Vertical Irregularity (ভবনের তীব্র উল্লম্ব অসামঞ্জস্যতা)

Please look for the question at supporting document

- Short Column
- Soft Storey / Weak Storey
- Out of Plane Setback (if the cantilever portion is greater than 2 feet)
- None

Short Column Due To

Please look for the question at supporting document

- Irregular Wall Opening
- Deep Spandrels
- Infill Walls

Soft / Weak Storey Due To

Please look for the question at supporting document

- Large Opening
- Fewer Walls or Columns
- One of The Stories is Particularly Taller Than Others

8. Moderate Vertical Irregularity (ভবনের সহনীয় উল্লম্ব অসামঞ্জস্যতা)

Please look for the question at supporting document

- In Plane Setback
- Sloping Site
- Split Level
- None

9. Plan Irregularity (ভবনের আনুভূমিক অসামঞ্জস্যতা)

Please look for the question at supporting document

- Torsional Irregularity
- Non-Parallel System
- Reentrant Corner
- Diaphragm Opening
- Out of Plane Offset (only exterior)
- None

Specify The Type of Reentrant Corner

Please look for the question at supporting document

- L- Shaped
- T- Shaped
- U- Shaped
- Large Opening
- Weak Link Between Larger Building Plan Areas

10. Pounding Potential

Please look for the question at supporting document

- Floors are not aligning vertically
- The building is at the end of a row of three or more buildings
- Minimum gap doesn't meet
- One building is two or more stories taller than the adjacent building
- None

11. Falling Hazard

Please look for the question at supporting document

- Unsupported Water Tank
- Unsupported Parapet
- Cornices
- Heavy Cladding
- Masonry Tower
- Chimney
- Flower Pot at Roof

- None

12. Geological Hazard

Please look for the question at supporting document

- Loose Fill
- Landslide
- Organic Soil
- None

13. Significant Damage (ভবনের দৃশ্যমান ক্ষতি চিহ্নকরণ)

- Visibly Sagging Beam/ Floor/ Slab
- Visibly Broken Beam/ Column
- Sloping Floor
- Large Exterior Cracks
- Visible Distress From Previous Earthquake
- Visible Fire Damage
- Visible Foundation Elements with Large Cracks
- Foundation Elements Exposed Due to Significant Erosion of Adjacent Soil
- None

Is Mortar Eroding Away?

- Yes
- No

Is There Any Exposed Rebar?

- Yes
- No

Is There Any Member Corroded?

- Yes
- No

14. Extent of Review

- Partial
- All Side

15. Interior Inspection

- Visible
- Entered
- None

Name of the Surveyor

APPENDIX D

Questionnaire for Household Survey



টাঙ্গাইল পৌরসভা এর এলাকা ভিত্তিক ভূমিকম্প ঝুঁকি নিরসন এবং ব্যবস্থাপনা

প্রশ্নপত্র নম্বর _____
 বিস্তৃত আইডি _____
 প্রশ্নকারীর গ্রুপ _____
 হোস্টিং নং _____

তারিখ _____
 ওয়ার্ড নং _____
 ক্লাস্টার নং _____

১। উত্তরদাতার সাধারণ তথ্য

১.১ উত্তরদাতার নাম _____

১.২ আবাসিক ভবনের মালিকানা (চিহ্ন দিন)

- সরকারী
- বেসরকারী (ব্যাসিগত)
- বেসরকারী (যৌথ মালিকানাধীন)

১.৩ ভবনটি নির্মাণ এর সাল _____

২। পরিবারের তথ্য (আবাসিক ভবনের ক্ষেত্রে)

২.১ পরিবারে সদস্য সংখ্যা _____

২.২ পরিবারের সদস্যদের বিস্তারিত বিবরন

সদস্য ক্রম	বয়স	লিংগ	শিক্ষাগত যোগ্যতা	পেশা	প্রতিবন্ধী আছে কি ? (হ্যাঁ/ না) প্রতিবন্ধকতার ধরন	ভূমিকম্প নিয়ে কোন সদস্যের প্রশিক্ষন আছে?(হ্যাঁ/ না)
১*						
২						
৩						
৪						
৫						
৬						
৭						
৮						

* উত্তরদাতা নিজে ১ম সদস্য হিসেবে বিবেচিত হবেন

বয়স	লিংগ	শিক্ষাগত যোগ্যতা	পেশা		প্রতিবন্ধকতার ধরন
১০ বছরের কম = ১	পুরুষ = ১	নিরক্ষর = ১	সরকারি চাকুরি = ১	ডাক্তার = ৭	মানসিক প্রতিবন্ধী = ১
১১ – ২০ বছর = ২	মহিলা = ২	প্রাথমিক = ২	বেসরকারী চাকুরি = ২	নার্স = ৮	শারীরিক প্রতিবন্ধী = ২
২১ – ৩০ বছর = ৩	অন্যান্য = ৩	মাধ্যমিক = ৩	ব্যবসা = ৩	শিক্ষক = ৯	বাক প্রতিবন্ধী = ৩

৩১ – ৬০ বছর = ৮ ৬০ বছরের বেশী = ৫		উচ্চ মাধ্যমিক = ৮ মাতক = ৫ মাতকোত্তর = ৬	শ্রমিক = ৮ ছাত্র = ৫ গৃহিণী = ৬	অবসরপ্রাপ্ত = ১০ বেকার = ১১ অন্যান্য = ১২	দৃষ্টি প্রতিবন্ধী = ৮ অন্যান্য = ৫
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২.৩ যদি কোন সদস্য ভূমিকম্প বিষয়ক প্রশিক্ষণ নিয়ে থাকেন তবে তার সাথে যোগাযোগ স্থাপনের জন্য মোবাইল নং _____

২.৪ উত্তরদাতার ভবনে মালিকানার তথ্য

- বাড়িওয়ালা
- ভাড়াটিয়া
- অন্যান্য

২.৫ এই পৌরসভা/ সিটি কর্পোরেশনে কত বছর যাবত আছেন? _____

২.৬ পরিবারের মোট মাসিক আয় (টাকায়)

- | | | |
|-------------------|--------------------|---------------------|
| ● ২০,০০০ এর কম | ● ৮০,০০০- ৫০,০০০ | ● ১,০০,০০০-১,৫০,০০০ |
| ● ২০,০০০ – ৩০,০০০ | ● ৫০,০০০-৭৫,০০০ | ● ১,৫০,০০০-২,০০,০০০ |
| ● ৩০,০০০- ৮০,০০০ | ● ৭৫,০০০- ১,০০,০০০ | ● ২,০০,০০০ এর বেশি |

৩ উত্তরদাতার ভূমিকম্প বিষয়ক সচেতনতা, জ্ঞান এবং ধারনা

৩.১ আপনি কি ভূমিকম্প সম্পর্কে জানেন?

- হ্যাঁ
- না

৩.১.১ হ্যাঁ হলে, ভূমিকম্প বিষয়ে আপনি কি জানেন? (খোলা প্রশ্ন** এবং একাধিক উত্তর গ্রহণযোগ্য)

- এটি একটি প্রাকৃতিক দুর্ঘটনা
- পৃথিবীর স্তলভাগ যে প্লেট দিয়ে নির্মিত তার নড়াচড়ার কারনে এটি হয়
- ভূমিকম্পে বাড়িয়ার কাপতে থাকে
- অবকাঠামোগত ক্ষতি হয়
- ভূমিকম্পে মৃত্যুবুকি রয়েছে
- কোনটি নয়
- অন্যান্য (উল্লেখ করুন) _____

৩.২ ভূমিকম্প হলে কি করতে হয়/ করবেন? (খোলা প্রশ্ন** এবং একাধিক উত্তর গ্রহণযোগ্য)

- কাঠের কিছুর নিচে লুকাবো
- দেয়াল/শক্ত পিলারের পাশে দাঢ়াবো
- মাথায় বালিশ/ কম্বল ইত্যাদি রাখবো
- দ্রুত ভবন থেকে নেমে যাবো
- ছাদে চলে যাবো
- ইলেক্ট্রিসিটি/গ্যাসের লাইন বন্ধ করবো
- খুব ভয় পেয়ে যাবো
- কিছুই করবো না
- অন্যান্য (উল্লেখ করুন) _____

**খোলা প্রশ্নসমূহে উত্তরদাতাকে কোন বিকল্প (option) দেওয়া হবে না

৩.৩ আপনি কিভাবে ভূমিকম্প সম্পর্কে এসব জানতে পেরেছেন (নিম্নোক্ত বিকল্প গুলোর মধ্যে নির্বাচন করুন এবং একাধিক উত্তর গ্রহণযোগ্য)

- গণমাধ্যম (টিভি / রেডিও ইত্যাদি)
- সংবাদপত্র/ লিফলেট
- স্কুল কলেজের বইপত্র
- স্কুল-কলেজ বা কোন প্রতিষ্ঠানের ভূমিকম্প বিষয়ক ড্রিল
- পরিবারের সদস্যদের সাথে কথা বলে
- এলাকার লোকজন/ প্রতিবেশীর সাথে কথা বলে
- ভূমিকম্প বিষয়ক অনুষ্ঠান/ কর্মশালার মাধ্যমে
- নিজে থেকেই জেনেছি
- সামাজিক যোগাযোগের মাধ্যম থেকে
- অন্যান্য (উল্লেখ করুন) _____

৩.৪ ভূমিকম্পের ঝুঁকি নিরসনে সক্ষমতা এবং সচেতনতা বৃদ্ধির জন্য নিম্নোলিখিত মাধ্যমগুলির মধ্যে কোন তিনটিকে সবচেয়ে বেশি পছন্দ করেন ক্রম উল্লেখপূর্বক প্রকাশ করুন

মাধ্যমের তালিকা	ক্রম
গণমাধ্যম ((টিভি / রেডিও ইত্যাদি)	
সংবাদপত্র/ লিফলেট	
বিভিন্ন সাংস্কৃতিক পরিবেশনা (নাটক / গান)	
ভূমিকম্প বিষয়ক এলাকা/ পাঢ়া ভিত্তিক সভা/ কর্মশালা	
ভূমিকম্প বিষয়ক ড্রিল/ ট্রেনিং	
অন্যান্য (উল্লেখ করুন)	

৩.৫ আপনি কি আপনার এলাকার ভূমিকম্প ঝুঁকি সম্পর্কে জানেন?

- হ্যাঁ
- না

৩.৫.১ হ্যাঁ হলে, আপনার এলাকাকে ভূমিকম্পের জন্য ঝুঁকিপূর্ণ মনে করার জন্য নিম্নের যে কারণ গুলি প্রযোজ্য সেগুলিতে টিক দিন এবং প্রযোজ্য কারণ গুলোর মধ্যে সবচেয়ে গুরুত্বপূর্ণ তিনটি কারণ চিহ্নিত করে তাদের ক্রম উল্লেখ করুন

সম্ভাব্য কারণ সমূহ	প্রযোজ্য হলে টিক দিন	ক্রম
তোগলিক অবস্থান এবং অবস্থা		
এলাকার মাটির ধরন ও প্রকৃতি (ভূতাত্ত্বিক অবস্থা)		
এলাকায় অনেক পুরানো ভবন রয়েছে		
অপরিকল্পিত স্থাপনা		
এলাকার ভবন এবং স্থাপনা সমূহ খুবই ঘনবসতি পূর্ণ		
খোলা জায়গার অভাব		
সরু রাস্তা		
এলাকায় অনেক জলাভূমি রয়েছে		
ভূমিকম্পের কারনে ভূমিধস হবার সম্ভবনা		
বৈদ্যুতিক দুর্ঘটনার কারণে আগ্নের সম্ভবনা		
অন্যান্য (উল্লেখ করুন)		

৩.৫.২ আপনার এলাকার ভূমিকম্প ঝুঁকি হ্রাস করার জন্য কি করা যেতে পারে বলে আপনি মনে করেন?

৩.৬ আপনি যে ভবনে বাস করেন সেটি কি ভূমিকম্পের জন্য ঝুঁকিপূর্ণ বলে আপনি মনে করেন?

- হ্যাঁ
- না

৩.৬.১ হ্যাঁ হলে, আপনার এরূপ ধারনার পেছনে নিম্নের যে কারণ গুলি প্রযোজ্য সেগুলিতে টিক দিন এবং প্রযোজ্য কারণ গুলোর মধ্যে সবচেয়ে গুরুত্বপূর্ণ তিনটি কারণ চিহ্নিত করে তাদের ক্রম উল্লেখ করুন

সম্ভাব্য কারণ সমূহ	প্রযোজ্য হলে টিক দিন	ক্রম
নিম্নমানের নির্মাণ সামগ্রী এবং নির্মাণ কৌশল		
অনেক পুরানো ভবন		
ভবনের দৃশ্যমান ফাটল		
জরুরি নির্গমন পথের অপর্যাপ্ততা এবং অব্যবস্থাপনা		
ভবনের নিচের মাটির ধরন		
ভবনের সাথে পার্শ্ববর্তী ভবনের স্বল্প ব্যবধান		
জলাভূমি ভরাট করে বানানো ভবন		
অন্যান্য (উল্লেখ করুন)		

৩.৭ আপনার কি ভূমিকম্পের অভিজ্ঞতা আছে?

- হ্যাঁ
- না

৩.৭.১ হ্যাঁ হলে, শেষ কত সালে ভূমিকম্প অনুভব করে ছিলেন ? _____

৩.৭.২ আপনি তাংক্ষণিকভাবে কি করেছিলেন? (খোলা প্রশ্ন*** এবং একাধিক উত্তর গ্রহণযোগ্য)

- কাঠের কিছুর নিচে লুকিয়েছিলাম
- দেয়ালের/ শক্ত পিনারের পাশে দাঁড়িয়ে ছিলাম
- মাথায় বালিশ, কম্বল ইত্যাদি নিয়েছিলাম
- পরিবারের সাথে ভবন থেকে নেমে রাস্তায় চলে গিয়েছিলাম
- ছাদে চলে গিয়েছিলাম
- ইলেক্ট্রিসিটি/গ্যাসের লাইন বন্ধ করেছিলাম
- ভয় পেয়ে গিয়েছিলাম
- কিছুই করিনি
- অন্যান্য (উল্লেখ করুন) _____

৪। উত্তরদাতার ভূমিকম্প দুর্যোগ ব্যবস্থাপনা বিষয়ক ধারনা

৪.১ আপনি কি ভূমিকম্প বিষয়ে পারিবারিকভাবে প্রস্তুতি নিয়েছেন ?

- হ্যাঁ
- না

৪.১.১ হ্যাঁ হলে, নিম্নোক্ত প্রস্তুতিগুলির মধ্যে কোনটি আপনারা গ্রহণ করেছেন (একাধিক উত্তর গ্রহণযোগ্য)

- তাংক্ষণিকভাবে ব্যবহার এবং সাথে রাখার জন্য প্রয়োজনীয় সরঞ্জাম একত্রিত করেছি
- ভূমিকম্প চলাকালীন অবস্থান করার জন্য বাড়ির ভিতরে অপেক্ষাকৃত নিরাপদ একটি জায়গা নির্ধারণ করেছি
- পরিবারের সদস্যদের সাথে ভূমিকম্প হলে করণীয় বিষয় নিয়ে আলোচনা করেছি
- প্রতিবেশি এবং ভবনের অন্যান্যদের সাথে আলোচনা করেছি
- অন্যান্য (উল্লেখ করুন) _____

৮.১.১ (ক) প্রথম বিবৃতিটির উভয়ের হাঁ হলে, ব্যবহার এবং সাথে রাখার জন্য নিম্নোক্ত কোন প্রয়োজনীয় সরঞ্জাম একত্রিত করেছেন?
(একাধিক উত্তর গ্রহণযোগ্য)

- ফাস্ট এইড বক্স
 - শুকনা খাবার
 - পানি
 - ট্রচ লাইট
 - টাকা
 - হাইসেল
- অন্যান্য (উল্লেখ করুন) _____

৮.১.১ (খ) দ্বিতীয় বিবৃতিটির উভয়ের হাঁ হলে, নিম্নের কোন স্থানটি/গুলোকে নিরাপদ হিসাবে বিবেচনা করেছেন?

- দরজার ফ্রেমের নিচে
- বীমের নিচে
- পিলারের পাশে
- দেয়ালের পাশে
- টেবিল/খাটের নিচে
- ছাদে
- সিঁড়িতে
- অন্যান্য (উল্লেখ করুন) _____

৮.২ আপনি কি ভূমিকম্পের পর প্রয়োজন সাপেক্ষে আশ্রয়কেন্দ্রে যাবেন?

- হাঁ
- না

৮.২.১ যদি হাঁ হয় তবে আশ্রয়কেন্দ্র হিসেবে নিচের যে জায়গাগুলো আপনি পছন্দ করেন সেগুলোর পাশে টিক দিনা কোনটি পছন্দ না হলে টিক এর পরিবর্তে পছন্দ না করার কারণটি লিখুন। পরবর্তীতে নিম্নলিখিত জায়গাগুলির মধ্যে কোন তিনিটিকে সবচেয়ে বেশি পছন্দ করেন ক্রম উল্লেখপূর্বক প্রকাশ করুন

জায়গার নাম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	শুধুমাত্র পছন্দের জায়গা গুলোর ক্রম
খোলা জায়গা		
খেলার মাঠ		
শিক্ষা প্রতিষ্ঠান		
ধর্মীয় প্রতিষ্ঠান		
সরকারি প্রতিষ্ঠান		
অন্যান্য (উল্লেখ করুন)		

৮.২.২ যদি না হয়, তবে কেন যেতে চান না ? _____

৪.৩ ভূমিকম্পের পর আপনি/ আপনার পরিবারের কোন সদস্য কি স্বেচ্ছাসেবক হিসেবে কাজ করতে ইচ্ছুক?

- ह्या
 - ना

৪.৩.১ যদি হ্যাঁ হয় তবে স্বেচ্ছাসেবক হিসাবে আপনি/আপনারা নিম্নলিখিত কাজগুলোর মধ্যে কোনগুলো করতে চাইবেন সেগুলোতে টিক দিন, যেগুলো করতে চাইবেন না সেগুলোতে টিকের পরিবর্তে কারণটি লিখুন।
পরবর্তীতে টিক দেয়া কাজ গুলোর মধ্যে কোন তিনটি বেশি প্রচল্ন করবেন ত্রুটি উল্লেখপূর্বক প্রকাশ করুন। (এক্ষেত্রে ছক ২.২ এর সদস্যক্রম অনুসরণ করতে হবে)

৪.৮ আপনি কি আপনার ওয়ার্ডের ডিজাস্টার ম্যানেজমেন্ট কমিটির কাজের সাথে সম্পৃক্ত হতে চান?

- হ্যাঁ
- না

৪.৯ আপনি কি বর্তমানে আপনার ওয়ার্ডের আর কোন কমিটি/ সামাজিক কার্যক্রমের সাথে জড়িত আছেন ?

- হ্যাঁ
- না

৪.১০ যদি হ্যাঁ হয়, তাহলে সেটি কি উল্লেখ করুন _____

৫। ভূমিকম্পে ঝুকি নিরসনে বাড়িওয়ালার সম্মতি (বাড়িওয়ালার জন্য)

৫.১ যদি আপনার ভবন ঝুকিপূর্ণ হিসেবে চিহ্নিত হয় তবে আপনি ভবন ঝুকিমুক্ত করনে/ শক্ত করতে রাজি আছেন? (ধারনা করুন, ভবন শক্ত করনের জন্য ঝুকির উপর নির্ভর করে বর্তমান নির্মান খরচের ৫% থেকে ৩৫% পর্যন্ত খরচ হতে পারে)

- হ্যাঁ
- না

৫.১.১ যদি হ্যাঁ হয় তবে আপনার কোন ধরনের সহায়তার প্রয়োজন আছে ?

- আর্থিক সহায়তা
- কারিগরী সহায়তা
- অন্যান্য

৫.২ যদি প্রয়োজন হয় তবে রাস্তা প্রশস্ত করনের জন্য আপনি কি আপনার ভূমির অংশ দেবেন ?

- হ্যাঁ
- না

APPENDIX E

Checklist for Temporary Shelter and Health Facility

Checklist for facility buildings suitable for temporary shelter

For Educational Institution

- Number of Teacher
- Number of Students
- Number of Staff
- Time Period of Institution

For Community Center

- Capacity

Checklist for health facilities suitable for emergency response

- Number of Doctor
- Number of Staff
- Number of Bed
- Existing Facility