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RETHINKING THE PUBLIC BUILDING AS POST DISASTER SHELTERS - IN THE CONTEXT OF OLD DHAKA

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ABSTRACT

Earthquake is one of the major disasters in Bangladesh. A strong earthquake will affect major urban centers like Dhaka, Chittagong, Sylhet etc. Damage and destructions will be massive and may cause immense economic losses for the entire country. It is therefore essential to be prepared for possible earthquakes and to take appropriate measures to minimize possible losses and damages. This would help to develop rational mitigation measures for minimizing the adverse impacts of earthquakes. To reduce earthquake vulnerability in urban areas as well as to save human lives, property etc - we need to set up earthquake preparedness plan or strategies for earthquake protection. Highly dense urban areas like old Dhaka, is experiencing physical vulnerability like unplanned growth, existence of vulnerable built environment, narrow street pattern, poor infrastructures etc. Thus several hundred thousand peoples are living an insecure life. A proper guideline is needed to reduce the effect of the catastrophe. In this regard under post disaster situation, shelters and other facilities are needed. For these purpose public buildings at neighborhood level like schools, religious buildings, community centers, hospitals etc. can serve the dual purpose and these places could be used as post disaster shelters. This paper aims to analyze the existing condition and location of these public buildings in old Dhaka. Also earthquake vulnerability assessment and countermeasures such as retrofitting and other measures that can be applied to use these buildings as workable post disaster shelters and to improve quality and quantity of open spaces regarding street pattern, communication etc. are studied.

Introduction

Old Dhaka with several hundred years urban settlements have thousands of people. They are living a precarious life at awfully dilapidated buildings in congested manner. Over the period of time old Dhaka is being denser. Lack of open spaces & narrow road width became the main reason for many natural disasters like earthquake. Poor infrastructures and vulnerable buildings

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caused most serious threat of collapse at old Dhaka. So disasters like earthquake will cause a severe damage to this area because at post disaster situation people will be either inside the rubbles of tumbled building or will not be able to reach any post disaster shelters. As this total area is devoid of proper open spaces and public buildings are at very poor condition so people of this area have no proper option for post disaster shelters. An organized policy will make a proper dual use for these public buildings & thus these buildings will serve proper during post disaster situation.

Study Area

Ward 68 of Old Dhaka is selected as the study area due to its earthquake vulnerability. The site is characterized by a high density of population living in a very compact land area with close proximity of buildings along a very narrow local street. In most cases it is difficult to differentiate the buildings from each other. The prevailing circumstance gives a view of buildings may collapse without any disaster like earthquake. The condition is unthinkable and unimaginable what may happen with an attack of earthquake. The location and condition of public buildings are not up to the standards because of its informal settlements. Figure 1 shows the building height within the study area and Figure 2 shows the public building and road layout in the study area.

Methdology

It is a very difficult and time-consuming task to assess the vulnerability of the existing buildings in any target area. The study includes two different visual screening methods, i.e. FEMA-RVS and Turkish Simple Survey (Level-I and Level-II) Procedure. The Level-I Turkish method is almost similar to the RVS method. The rapid visual screening (RVS) method has been used in this research to assess all public buildings in 68 word and the Turkish Level-I and Level-II, a more detail analysis of the building, is used to assess the structures proposed to be used as evacuation place. The religious place like mosques, the community centers, educational institutes like schools, colleges and other public places along with the open spaces like park, playground are considered as evacuation sites.

FEMA Rapid Visual Screening

The Federal Emergency Management Agency (FEMA) of the United States of America has developed pre-earthquake screening method of potential seismic hazard assessment of buildings based on rapid visual screening method, widely known as RVS method originated in 1988, with the publication of the FEMA 154 Report. It is generally used for rapid evaluation of seismic vulnerability profiles of existing building stocks. RVS method is used to quickly determine if detail evaluation of existing building is required. The objective of these methods is to identify, make inventory and rank all high-risk buildings in a specified region so that a strategy of priority based interventions to buildings can be formed. This screening methodology is encapsulated in a one page form, which combines a description of a building, its layout and occupancy, and a rapid structural evaluation related to its seismic hazard. This procedure requires only visual inspection and limited data collection. It is a "sidewalk survey" approach that enabled users to classify surveyed buildings into two categories: those acceptable as to risk to life safety or those that may be seismically hazardous and should be evaluated in more detail by a design professional experienced in seismic design.

The Data Collection Form of RVS includes space for documenting building identification information, including its use and size, a photograph of the building, sketches, and documentation of pertinent data related to seismic performance, including the development of a numeric seismic hazard score. Basic Structural Hazard Scores based on Lateral Force Resisting System for various building types are provided on the form and the screener circles the appropriate one. The screener modifies the Basic Structural Hazard Score by identifying and circling Score Modifiers related to observed performance attributes, by adding (or subtracting) them a final Structural Score, 'S' is obtained (Imtiaz et al, 2007).

The score below which a structure is assumed to require further investigation is termed as "cut-off" score. The value of "cut off" score and choice of RVS form depends on the seismic zonation of the area. It is suggested that buildings having an S score less than the "cut-off" score should be investigated by an experienced seismic design professional experienced in seismic design. If the obtained "final score" is greater than the "cut-off" score the building should perform well in a seismic event. A score of 2 is used in this study as a "cut-off" score.

Turkish Simple Survey Procedure

Another approach of rapid visual screening was employed for assessment of seismic vulnerability of structure in Turkey. The Turkish Simple Survey procedure is a two level seismic risk assessment procedure which has been proposed on the basis of statistical correlations obtained by employing a database of 477 damaged buildings surveyed after the 1999 earthquake in the cities of Kocaeli and Düzcec in Turkey (Sucuoglu and Yazgan, 2003). The method uses two levels seismic assessment based on several building parameters that can be easily observed or measured during a systematic survey. The first level incorporates recording of building parameters from the street side regarding a structural form and the ground condition and involves the observation of the parameters, the number of stories above ground, presence of a soft story, presence of heavy overhang, apparent building quality, and presence of a short column.

In the second level, these are extended by structural parameters measured by entering into the ground story. In the second level the parameters of first level are confirmed or modified through closer observations. Then a sketch of the framing plan at the ground story is made and the dimensions of columns, concrete and masonry walls are measured. The added parameters in this stage are pounding between adjacent buildings, topography effect, plan irregularity, redundancy, and strength index. The consistency in distribution of lateral loads to frame members is judged by redundancy and the strength index figures out the influence of size of the vertical members of the building, material strength, frame geometry etc. on the lateral strength of the building. The results of the Level - II procedure can be used to determine the potential status of the selected buildings and to further short-list the buildings requiring detailed vulnerability assessment.

The basic scoring for both the levels are based on the Height of the building (number of stories) and Local Soil Conditions where three intensity zones are specified in terms of associated PGV (Peak Ground Velocity) ranges (Imtiaz et al, 2007). Once the vulnerability parameters of a building are obtained from two-level surveys and its location is determined, the seismic performance and vulnerability scores are calculated. A "cut-off" performance score of 50 has been suggested for both survey levels.

Figure 1 Building height of the study area

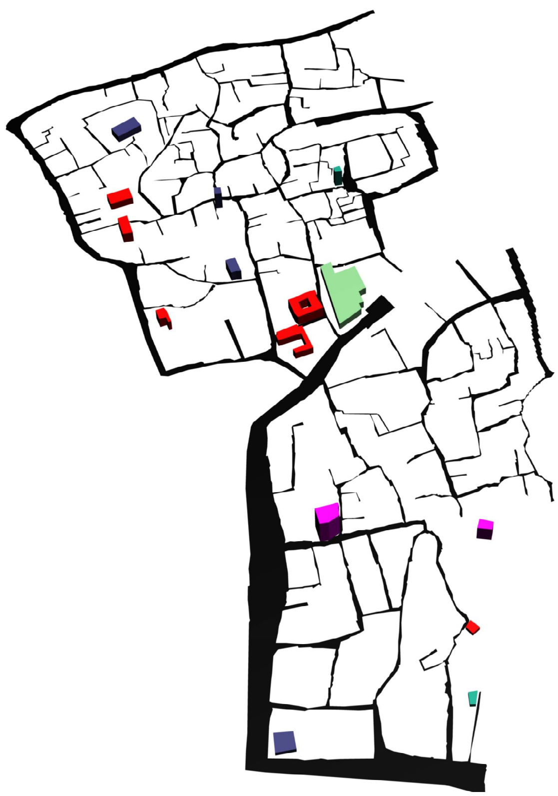


Figure 2 View showing public building and road layout in ward 68

Data Interpretation and Analysis

Vulnerability Assessment of Public Buildings by RVS Method

The earthquake vulnerability of the buildings is assessed using the Rapid Visual Screening (RVS) Method and detail evaluation of the proposed evacuating buildings is made using the Turkish Level I and Level -II method. A total number of 1064 Buildings have been analyzed using Rapid Visual Screening (RVS) method. On a general view, the soil type of Ward no. 68 has been considered as Stiff. RVS score '0' is given to the buildings that showed negative results, that means the buildings are in emergency need of detail evaluation by any structural engineer and take further actions like retrofitting, etc. based on the result found. The results show that 44% score for buildings was found to touch the cut off value according to FEMA method and all of them require further detailed analysis on vulnerability to determine the level of actual risk.

Considering the existing site condition, it can be assumed that such a large number of buildings may not be vulnerable if an earthquake hits and if 1.5 is considered as the cut-off score then most of the buildings fall in the safe region and do not require detail structural analysis. Figure 3 shows that with the cut-off value 1.5, 67% of the total surveyed buildings are not vulnerable in any earthquake disaster.

Vulnerability Assessment of Public Buildings by Turkish Method

A more detail analysis of buildings is done in Turkish Level-I and Level-II method in comparison with the RVS method. It has been found from studies that the Turkish method is more compatible in the circumstances of our country. The detail evaluation of 11 structures proposed to be used as evacuation sites are done.

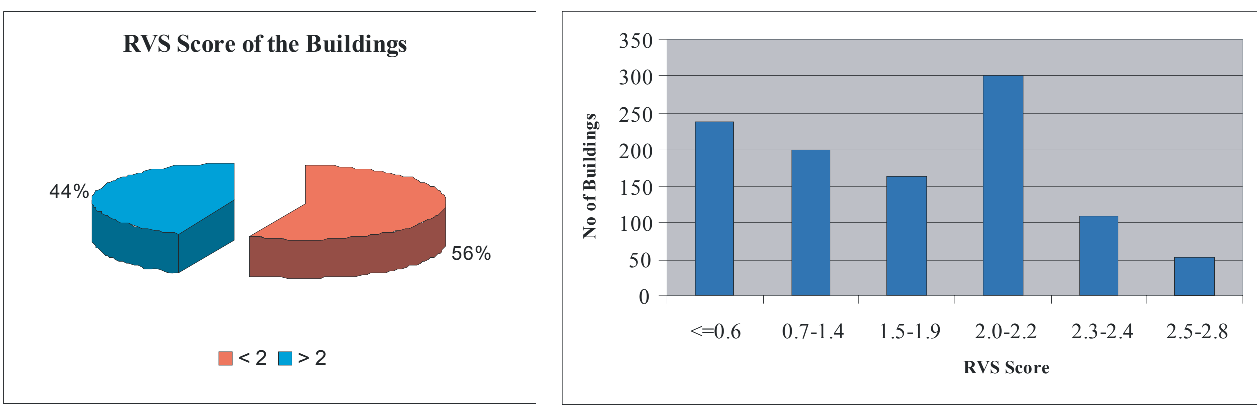


Figure 3: Buildings according to the RVS cut-off Score

Review of Building Configuration Analysis against Earthquake

Architectural Consideration and Geometric configuration

The following briefly describes the most relevant aspects of the impact of geometric configuration on the seismic response of buildings, as well as the corrective measures required. Due to their complexity and their close relationship with buildings' use of space and form, configuration problems must be taken into account from the very earliest stages of architectural design. Architects and designers should have a thorough understanding of the relevant issues.

The length of a building determines its structural response in ways that are not easily determined by the usual methods of analysis. Since ground movement consists of the transmission of waves, which occurs with a velocity that depends on characteristics of the soil on which the structure stands, the excitation that takes place at one point of support of the building at one time differs from the excitation at another time, a difference that is greater to the extent that the length of the building is greater in the direction of the seismic waves. Short buildings adjust more easily to the waves than long buildings, and undergo similar excitation at all supports. The usual correction for the problem of excessive building length is to partition the structure in blocks by the insertion of seismic expansion joints in such a way that each block can be considered a shorter building. These joints must be designed to permit adequate movement of each block without the danger of their striking or colliding with each other. Long buildings are also more sensitive to the torsion or horizontal rotation resulting from ground movements, because the differences in the transverse and longitudinal movements of the supporting ground, on which this rotation depends, are greater.

Concentration of stress arises in buildings with complex floor plans. A complex plan is defined as that in which the line joining any two sufficiently distant points lies largely outside of the plan. This occurs when wings of significant size are oriented in different directions, for instance in H, U, or L shapes.

Comparison of Public Buildings Using RVS, Turkish Method and Building Configuration

The detail evaluation of 11 structures proposed to be used as evacuation shelters or sites are done. Table 1 presents RVS score, Level I and II scores from Turkish methods and building configuration data for the eleven public buildings. Figures 4 to 6 present proposed shelter locations and their geometric configurations.

Table 1. Scores from RVS and Turkish Methods and Building Shape.

Sl. no.	Name and Address	RVS Score	Turkish Method		Shape
			Score in Level-I	Score in Level-II	
01	Ahmed Bawyani School	0	75	85	Rectangle and U-Shape
02	Anandomoyee Girls' High School Structure 01	2.2	110	108	L-Shape
	Structure 03	2.2	115	120	
03	Haybat nagar Dewan School	1.7	115	113	Square
04	Zindabahar 2nd lane Jame Mosque	2.4	50	47	Rectangular
05	Jumman Community Center and Ward Commissioner's Office	1.7	125	125	Irregular
06	Mahutuli Mosque	2.2	125	130	Square
07	Maulana Mosque	2.2	125	130	Square
08	Shahjada Mia Jame Mosque	1.7	105	106	L-Shape
09	Jhabbu Khanam Jamme Mosque	1.9	90	100	Irregular
10	Islampur Jamme Mosque	0.4	65	57	L-Shape
11	Kamranga Mosque	0	110	106	Square

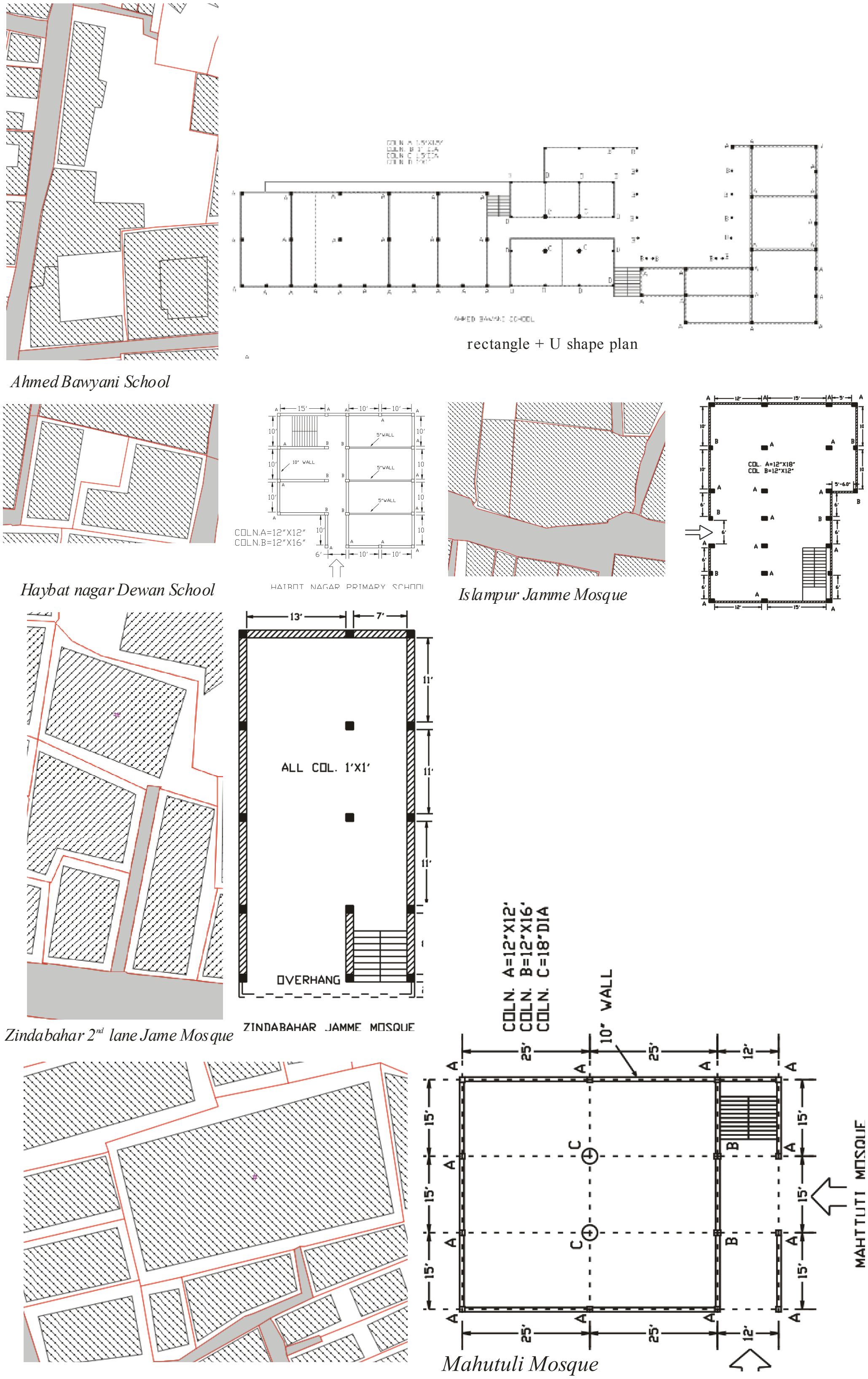
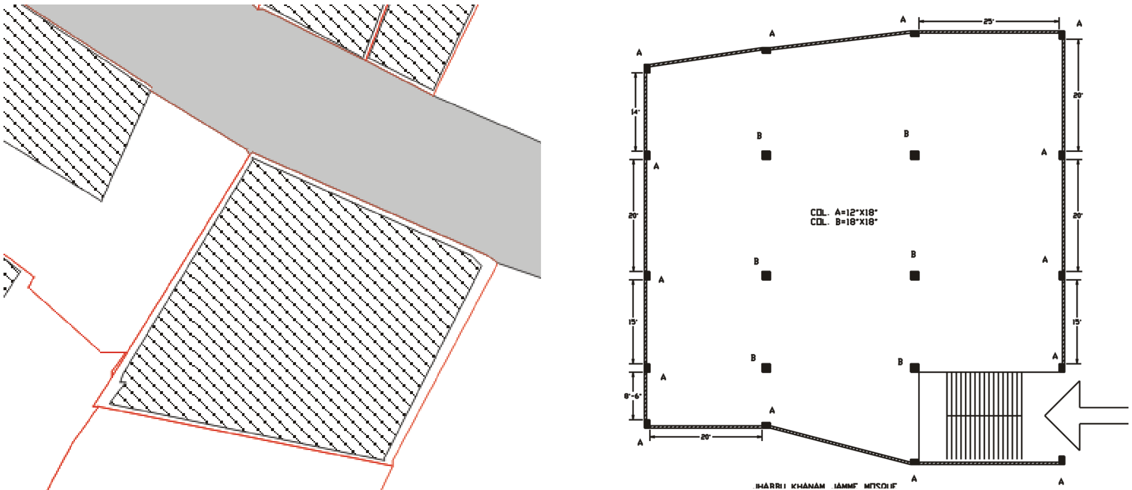
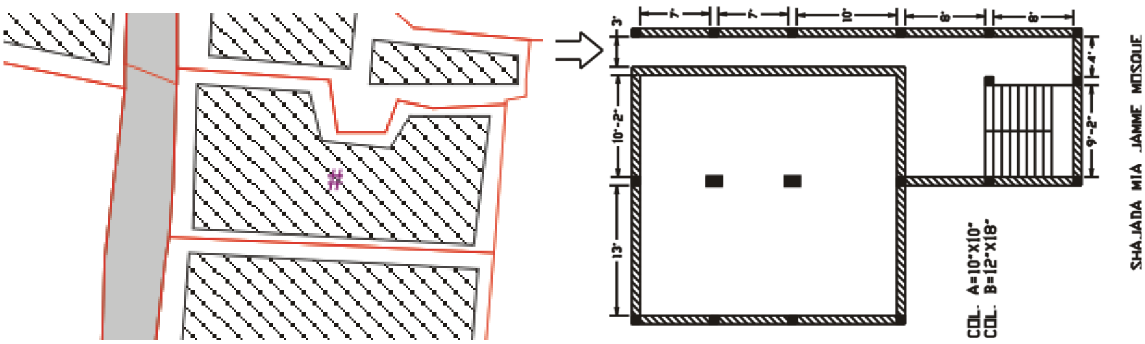


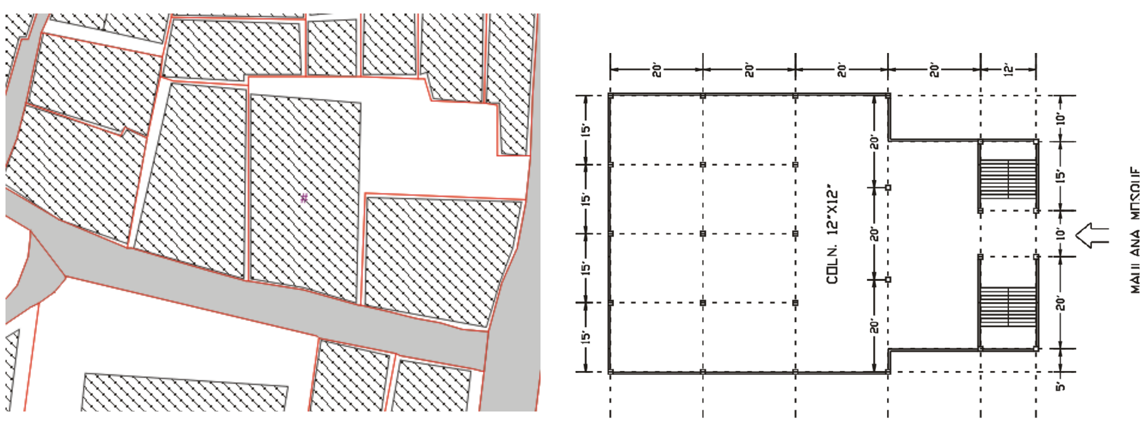
Figure 4. Geometric configurations of some of the proposed shelters



Jhabbu Khanam Jamme Mosque



Shahjada Mia Jame Mosque



Maulana Mosque

Figure 5. Geometric configurations of some of the proposed shelters

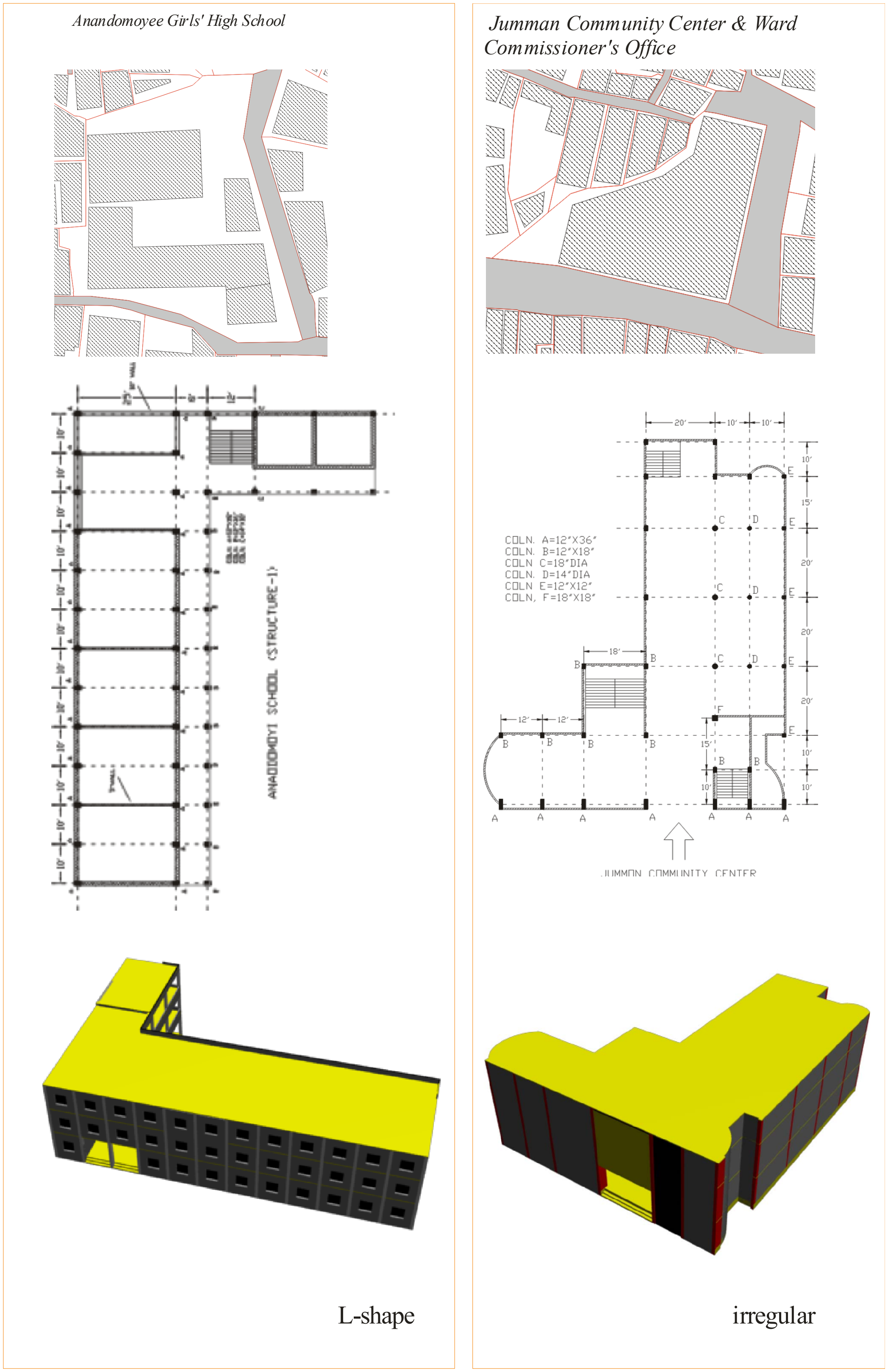


Figure 6. Geometric configurations of some of the proposed shelters

It is clear that most of the structures fall below the cut-off score in the RVS method but in the Turkish Method, most of them fall above the cut-off score i.e. they don't need further detail analysis. The Zindabahar 2nd lane Jame Mosque requires more detail structural analysis based on Turkish method although it's RVS score resulted above the cut-off value. Contrary some structures resulted for detail evaluation in RVS method while the Turkish methods showed they do not need any further analysis by specialist. Again the Islampur Jamme Mosque has just passed the cut-off score and the RVS score is also negative. So it also requires detail evaluation.

Conclusions

This paper presents the methods of earthquake vulnerability assessment of the public buildings of ward 68 in the old part of Dhaka city. Both RVS and Turkish methods have limitations in terms of incorporating the parameters relevant to the design and construction practices in Bangladesh. The methods provide a general idea and knowledge on the vulnerability of the buildings based on which an effective evacuation shelter or post disaster shelter can be proposed to reduce loss caused by any urban disaster.

The ultimate target of this study is to develop a GIS based evacuation plan based on the existing site condition, buildings, road network system, and proposed public building as earthquake shelters etc. For this purpose, the whole area must be divided into different groups according to vulnerability and capacity of evacuation places. A 3D model of the area showing the escape routes with the shortest path directing to evacuation shelters from each specified area will be prepared. This paper only describes the vulnerability of the existing public buildings based on the actual field condition.

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