

EARTHQUAKE: EMERGING THREAT FOR DHAKA CITY

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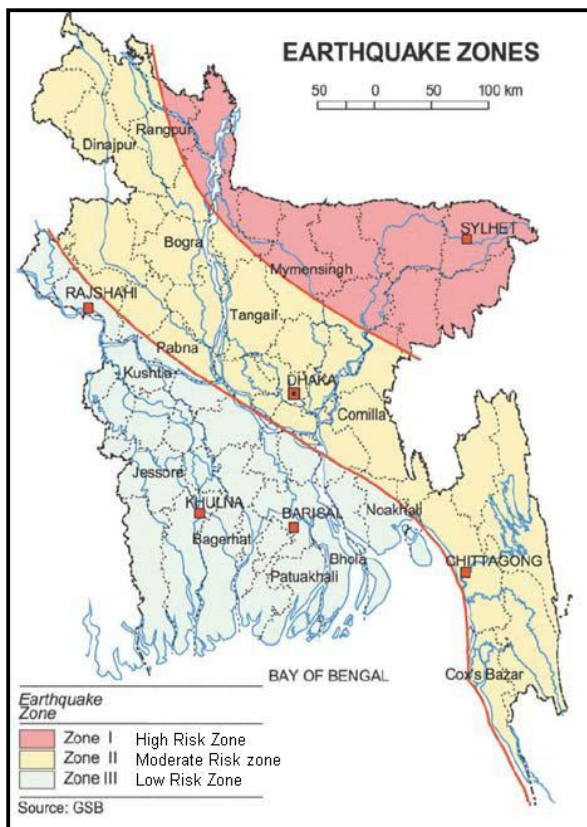
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Dhaka, the capital city of Bangladesh is one of the fast growing cities in the world. Since its independence, rapid urbanization turned Dhaka as one of the megacities of the world. The city had already become the eleventh largest city in the world in 2000 and is projected to be the sixth most populous city by 2010 (Islam, 2005). In 2010, it becomes the 2nd worst city of the world. The rapid growth of Dhaka's population forced haphazard & unplanned development and speedy construction of new buildings in any and every available space. Due to this, the capital city is now in a serious threat of upcoming massive disaster like earthquake. . Some incidents of recent building collapse in and around Dhaka City have provided impetus of increasing concern about the seismic vulnerability of the built environment in Dhaka City. Bangladesh lies in a seismically active zone making the occurrence of major earthquakes a realistic possibility. Though Dhaka city lies in the moderate risk zone (Fig 1) due to some others risk factor like high population density, unplanned urbanization and lack of open spaces, the city is most vulnerable than any other parts of Bangladesh. Geographically Bangladesh is located close to the junction of two subduction zones created by two active tectonic plates: the Indian plate and the Eurasian plate. Moreover, the country is surrounded by the Himalayan Arc, the Shillong Plateau and the Dauki fault system in the north, the Burmese Arc and ArakanYoma anticlinorium in the east, and the Naga Disang Haflong thrust zone in the northeast (Ali and Choudhury, 2001). The capital city is vulnerable to the earthquake as the country is in an active region in terms of vertical and horizontal movement of tremor. The existence of an active fault has been proved in Haluaghat of Mymenshingh recently, adding further risk to the vulnerability (URL 1).

Based on the record of the Geological Survey of Bangladesh, the country has experienced at least 465 earthquakes of minor-to-moderate magnitudes between 1971 and 2006. The actual number of earthquakes is considered to be many more than this, because many tremors are not recorded due to a lack of proper seismic equipment in the lone operational observatory in Chittagong. Seismic experts consider recent repeated earthquakes of low to medium magnitude as an advance warning for a massive, and potentially disastrous earthquake in the near future, as these tremors fail to release the majority of the stress that accumulates within fault rupture zones (Bolt, 2005; DPF, 2003). Seismic experts also suspect that if an

earthquake with a magnitude 7.0 on the Richter scale occurs in large cities of Bangladesh, there would be a major human tragedy and economic disaster due to the structural failure of many buildings built in these urban centers without the use of proper construction materials and in violation of building codes (Bimal Kanti Paul, 2010). Although the Bangladeshi government has developed building codes, which include detailed guidelines for earthquake resistant design of concrete and steel structures, these codes are not officially enforced. In the absence of an effective enforcement mechanism, it is widely believed that many new buildings do not have adequate provision for seismic resistance. As a consequence, the number of people living and/or working in unsafe structures in Dhaka is increasing (Bimal Kanti Paul, 2010).



Dhaka is too much vulnerable of earthquake disaster due to some reasons. First of all the population density is very high in Dhaka city. Secondly, it is predicted that the secondary hazard like fire break out from gas and electricity line will have more disastrous impact after earthquake. Thirdly, not only building codes are not maintain during construction time of most of the high rise apartment buildings and most garment factory buildings but also they have been constructed without open spaces and most have encroached upon the streets and roadways. As a result, the collapse of these structures will block streets, further hindering rescue operations.

Fig 1: Seismic Zoning Map of Bangladesh

According to Mehdi Ahmed Ansary, vice-president of Bangladesh Earthquake Society, a tremor measuring 7 magnitudes on the Richter scale may destroy about 35 percent buildings and kill around 25,000 people. He blamed unplanned urbanization and construction of buildings defying the building code as the major causes of this situation. He also added that depending on what time of day earthquake strikes, 22,000 to 28,000 people might perish in structural collapses while the number of seriously injured may range between 86,000 and 107,000. A recent study (2007) conducted by his students results that the economic loss of an

earthquake of 8 magnitude is estimated about 1.76 billion U.S. dollars for Dhaka city (URL 3). According to expert an earthquake measuring 7 on the Richter scale may cause havoc in Dhaka destroying or damaging many high-rise buildings thus wiping out 32 per cent of the country's current ADP of Tk 160000 million and the most vulnerable structures are the 4 to 5 storey buildings supported on unreinforced brick masonry walls (usually with 250mm thickness). These are gradually replacing the traditional low-rise structures (e.g. timber-framed lightweight houses in Sylhet) which have much better performance in case of earthquakes. But if an earthquake measuring 7 on the Richter scale hits the country, around 1, 31,000 people are likely to die and one-fourth of the buildings will collapse (URL 2).

Any physical phenomenon associated with an earthquake that may produce adverse effects on human activities is termed as earthquake hazard. This includes surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, tsunami, and their effects on land use, man-made structures, and socio-economic systems. A commonly used restricted definition of earthquake hazard is the probability of occurrence of a specified level of ground shaking in a specified period of time. Similarly, earthquake risk is the expected (or probable) life loss, injury, or building damage that will happen, given the probability of earthquake hazard. Earthquake risk and earthquake hazard are occasionally used interchangeably.

The occurrence of earthquakes with magnitude averaging around 5 in Richter scale is quite frequent especially in its eastern region of Bangladesh. Although, Dhaka has not been experienced with any moderate to large earthquake in historical past, even then the earthquake of December 19, 2001 with magnitude of 4.5 and focal depth of 10 km located very close to Dhaka is certainly an indication of its earthquake source and vulnerability. In addition, micro-seismicity data also supports the existence of at least four earthquake source points in and around Dhaka. The earthquake disaster risk index has placed Dhaka among the 20 most vulnerable cities in the world. Dhaka with its population of around 13 million and enormous poorly constructed and dilapidated structures signifies extremely vulnerable conditions for massive loss of lives and property in the event of a moderately large earthquake (Khan, 2004).

The recently measured plate motions at six different sites of Bangladesh including Dhaka; (the research being jointly conducted by Lamont-Doherty Earth Observatory, Columbia University, USA and the Department of Geology, Dhaka University) clearly demonstrate that Dhaka is moving 30.6 mm/year in the direction northeast. Further, the rate of strain accumulation is relatively high in and around Dhaka. It may precipitate in an earthquake of magnitude 6.8 in the event of the release of accumulated strain. The shallow subsurface of Dhaka is also characterized by number of faults of variable dimensions. These faults are

vulnerable to motion where these coincide with the zones of high particle velocity (Khan, 2004).

The coincidence of the zones of high particle velocity with the location of faults suggests that the western part of Dhaka city from Mirpur-Kalyanpur to Pagla along Buriganga river and the eastern part of Dhaka city from Uttar Khan-Badda to Demra along Balu river has emerged as high risk zone (Fig 2 and 3). The peak ground acceleration in these areas has been calculated ranging between 0.3 to 0.35 if an earthquake of magnitude 5.6 occurs in and around Dhaka city. The resonant length in these areas suggests an optimal height beyond five stories; additional seismic factor needs to be introduced in addition to general seismic factor which is introduced based on seismic factors of the site specifically for earthquake resistant building code. The entire Dhaka megacity has been looked upon from earthquake hazard point of view. It has been divided into four zones of earthquake hazard vulnerability ranging between very high risks and low risk.

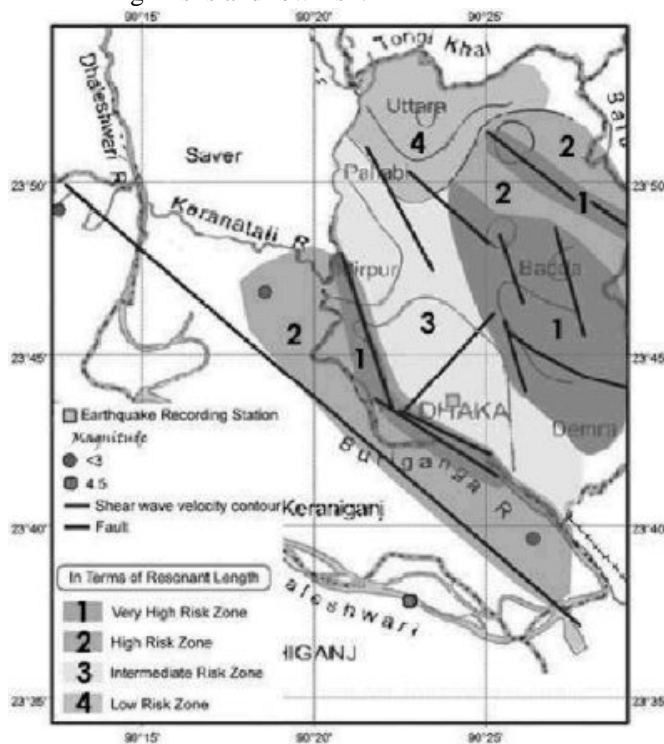


Fig 2: Seismic Vulnerability Map of Dhaka City

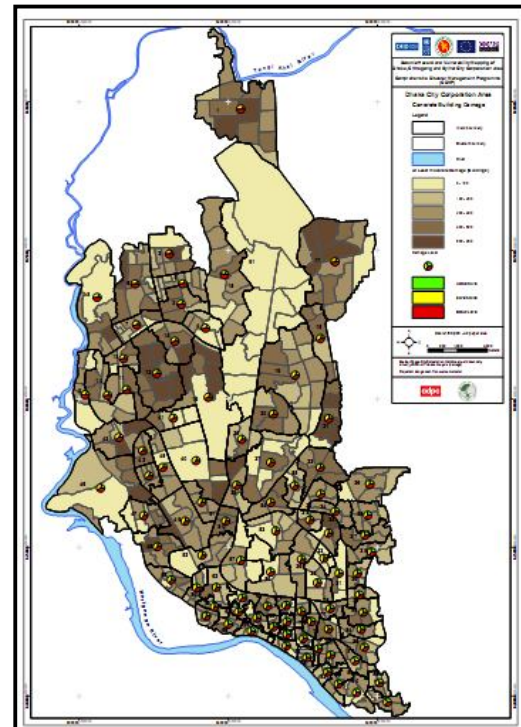


Fig 3: Earthquake Damage Map of Dhaka City

PREVENTION MEASURES

Earthquake cannot be prevented. But certainly it is high time to be much more concerned about the probable impending earthquake in order to minimize the loss of lives and property in national interest.

For better understanding of all the possibilities of earthquake risk reduction, it is important to classify them in terms of the role that each one of them could play. Therefore, in the pre-earthquake phase, preparedness, mitigation and prevention are concepts to work on. Post-disaster, immediate rescue and relief measures including temporary sheltering soon after an earthquake until about 3 months later and re-construction and re-habilitation measures for a period of about six months to three years need to follow.

To encapsulate, the most effective measures of earthquake risk reduction are pre-disaster mitigation, preparedness and preventive measures to reduce vulnerability and expeditious, effective rescue and relief actions immediately after the occurrence of the earthquake. Depending upon the calamity and its consequences, strategies can also be divided into long term (five to fifteen years), medium term (one to five years) and short term (to be taken up immediately in high risk areas). Since it has been realized that earthquakes don't kill people but faulty constructed buildings do, the task of reducing vulnerability of structures and buildings will be the key to earthquake risk reduction. Also, pre-disaster preparedness through a post-earthquake response plan, including training of the concerned personnel in various roles, is considered essential for immediate and effective response after an earthquake occurrence. The major action points are highlighted in the following paragraphs.

Pre-disaster Preventive Measures

Long-term measures

- Bangladesh should prepare a proper seismic risk map with zonation and micro-zonation depending on the intensity and frequency of seismic activities. There should be detailed seismic risk map especially for Dhaka city considering its poor physical structure and high population density.
- There should be appropriate standard building codes and specifications in construction practice to safeguard against seismic forces. More importantly, seismic codes and specification should be followed in all public and private construction and law enforcement authorities to take action against the violators of building codes.
- Incorporating earthquake resistant features in all buildings at high-risk areas.
- Making all public utilities like water supply systems, communication networks, electricity lines etc. earthquake-proof. Creating alternative arrangements to reduce damages to infrastructure facilities.
- Constructing earthquake-resistant community buildings and buildings (used to gather large groups during or after an earthquake) like schools, dharamshalas, hospitals, prayer halls, etc. especially in seismic zones of moderate to higher intensities.
- Supporting non governmental organization in various aspects of disaster mitigation, preparedness and prevention and post-disaster management.

- Evolving educational curricula in architecture and engineering institutions and technical training in polytechnics and schools to include disaster related topics.

Medium term measures

- Retrofitting of weak structures in highly seismic zones. It is very important for Dhaka city as 60% building of this city are not able to survive against ground shaking.
- As community peoples are the ultimate victim of any disaster, the communities involved in the process of disaster mitigation through education and awareness. In this case Community-based Earthquake Risk Management process should be initiated by promoting awareness among community people what should be the response in times of earthquake. There should be regular drill regarding this responsiveness. Mock Drill is very effective for raising awareness as well as capacity enhancement especially in the field of disaster preparedness and response. It is also an effective way of learning with entertainment.
- Networking of local NGOs working in the area of disaster management. They should be trained up to strengthen their capacity and capabilities.

Short term measures

As earthquake has no warning system there should be some short term measure which will considerably reduce the vulnerability in individual level such as,

- Place large and heavy objects at the ground level or in the lower shelves of storage shelves.
- Keep chinaware, glass ware and other breakable objects in such a way that these do not fall off the shelves with upturned lips will help holding such materials.
- Appliances that can be moved can break electrical or gas lines and must be anchored to a stable location with flexible connections.
- Flammable liquids must be stored securely away from flame.
- Beds should not be placed near windows.
- Every member of the family should know how to switch off electricity and gas mains at the time of emergency
- Every family should keep a first aid box always ready and every family member should know how to use it because outside help may be delayed.

During Earthquake Emergency

- First of all no one should panic because it will not help anything. Everyone should think the consequences of any action during earthquake.
- Do not run outside in panic. Choose a safer place to stay during shaking.
- If indoors look for falling objects.

- In danger get under a table, bed, door lintel or stand in a corner away from the window.
- If outside avoid being close to high buildings, walls, power poles and other objects that could fall.
- If possible move to an open space area away from hazards.
- In the city if you are in a high floor do not run down the stairs or use a lift. Wait till the shaking stops and proceed down on stairs.

Preventive Measures Immediate After Earthquake

- Maintenance of law and order, prevention of trespassing, looting etc.
- Evacuation of people.
- Recovery of dead bodies and their disposal.
- Medical care for the injured.
- Supply of food and drinking water.
- Check for fire breakouts.
- Temporary shelters like tents, metal sheds etc.
- Repairing lines of communication and information.
- Restoring transport routes.
- Be prepared for additional earthquake shocks called 'after shocks' which may cause additional damage. Cordoning off severely damaged structures that are liable to collapse during aftershocks.
- Co-ordination between various agencies involved in rescue and relief work is extremely important to avoid gaps (both in communication and field work) and duplication of effort. So coordination should ensure in every steps of relief and rescue operation.

Post Disaster Measures (Consolidation and Re-Construction)

During the time of emergencies, affected people need to be involved in the relief activities so as to create a feeling of self-reliance. Also, the sooner they are integrated, the shorter will the period of relief.

Post-disaster work would involve:

- Detailed survey of buildings for assessment of damage and repair/ reconstruction and seismic strengthening or demolition.
- Selection of sites for new settlements, if required.
- Execution of the reconstruction programme.
- Review of the existing seismic zoning maps and risk maps.

- Review of seismic codes and norms of construction.
- Training of personnel, engineers, architects, builders and masons.

From the above discussion it is clear that one earthquake of moderate intensity would kill thousands of people and destroy enormous national property. Death is certain for all human beings but painful death is not desirable. That's we should prepare our self to cope the impact of earthquake disaster and try to minimize the losses as less as possible at every level of community from everyone's position.

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