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3.8 Magnitude Earthquake in Sylhet Area, Bangladesh - A Case Study of School Building Damage

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Abstract: A minor earthquake (magnitude 3.8) hits the Sylhet area, Bangladesh at 18:29:21 BST on 07 June 2021. The epicenter of the earthquake is located about 10 km south of Sylhet City Corporation (SCC) area. SCC is located in the most active seismic zones of Bangladesh. A high school building in the SCC area was moderately damaged due to the earthquake. Building damage, geology, and geomorphology of the area were checked by field inspection, image analyses, literature review, and online resources. The building was built on an artificially filled big pond (named Laldighi) with unconsolidated soft soil. The school building was constructed in 2006, and horizontally (N-S direction) and vertically extended in 2018. A series of N-S direction large diagonal and linear cracks were observed in the walls, pillars, floors, and staircases of the building due to the earthquake. Septic tanks and pipelines were located on the south side of the damaged building and were settled down at different rates. In June 2021 total of 9 earthquake of magnitude between 3 and 4 occurred in Bangladesh. Though low magnitude earthquake occurs frequently, usually significant damage, like in case of the above-mentioned earthquake, are not reported. Therefore, we recommended geoscientists, engineering geologists, urban planners, civil engineers, and policymakers to carry out detailed geological studies for sustainable urban and infrastructure development plans.

Keywords: ***Earthquake, Laldighi Sylhet, Sustainable development, Infrastructure damage, Engineering geology.***

Introduction

A 3.8 magnitude earthquake occurred near Sylhet area, Bangladesh at 18:29:21 BST on 07 June 2021 (BMD, 2021). The epicenter of the earthquake is located about 10 km south of Sylhet City Corporation (SCC) area and about 188 km northeast of the capital Dhaka. A school building was damaged by this shallow earthquake (focus depth 10 km) (USGS, 2021). This incident has been reported in several electronic and print media and discussed in different forums. Local people and the departments concerned were concerned by this incident of a school building damaged by a minor earthquake.

Methodology

This study was done by walkover survey, literature reviews and used secondary data from different sources. GPS, android mobile phone, measuring tape and scale were used for GPS coordinates photos and measurements of crack and settlement. Building damages are classified according to EMS-98 (Grünthal, 1998). Aerial photographs were used for evaluation of the geomorphology of the damaged building site and surroundings. The trend analysis of landfilling activities of Laldighi has been studied by using historical google earth imagery, aerial photographs and fieldwork. Standard Penetration Tests (SPT) were executed at the damaged building site down to 18 m depth. The ASTM methods were applied for laboratory testing.

Results

The SCC area lies on the most seismically active zone in Bangladesh and PGA value is 0.36 g (BNBC, 2020). The two-story Badar Uddin Ahmed Kamran building of Raja GC High School was damaged due to the 7 June 2021 event, a minor and shallow earthquake. This building was constructed in 2006 and horizontally and vertically extended on 2018 by the Education Engineering Department. A series of N-S diagonal cracks were observed on the outside and inside of the pillar and wall (shown by the red arrow in Figure 1a). Some diagonal cracks created gaps or apertures where light from outside could be seen through the wall. Plaster of both side of the cracks were fall (shown by red arrows in Figure 1b and c). The septic tank with the pipelines were settled at different rates due to this earthquake and maximum 10 inches were settled at the S-W corner of the septic tank. A pipeline of the septic tank also was settled at a different rate. According to EMS-98 (Grünthal 1998), building damages are classified as Grade 2 (moderate damage class/category).

The damaged school building is in a landfill area of Laldighi. Geomorphologically, Laldighi is situated at floodplains and level hills. Lithologically, the building ground consists of soft silty clay, loose silty sand, medium stiff silty clay, medium dense fine sand and hard silt. SPT N-values fluctuated from 3 to 6 at 1.5 to 11.0 m depth and then gradually increase up to 50 at 18.0 m depth. Unconfined compressive strength (UCS) ranges from <0.25 to 0.5 and <0.50 to 1.0 ton/ft for the silty clay layers at 0 to 2 and 8 to 11 m depth

respectively, and UCS is over 4.0 ton/ft for the silt layer at 15.5 to 18.0 m depth. The sieve analysis result indicate that coarser particles are composed of 95% sand and 5% silt and clay; the hydrometer analysis result indicates that finer particles are composed of 30% clay, 67% silt, and 3% sand. Atterberg limits analysis indicates that liquid limit, plastic limit, and plasticity index are 48%, 26%, and 22%, respectively, and specific gravity is 2.65 for the silty clay at 1.5 m depth. Friction angles were found 30.26 and 29.36 at 13.5 and 15 m depth samples respectively. Cohesions are 1.93 psi and 2 psi for samples at 13.5 and 15 m depth, respectively.

Groundwater level was 1.5 m at the damaged building site during fieldwork. The saturated sand layer may have the potential for liquefaction, and soft filling materials with different thickness were triggered to differential settlement of the damaged building. Quakes of magnitudes between 3 and 4 occur frequently in all over the world, as well as in Bangladesh, but there are no reports on significant damage like in the case of the studied school building damage. According to the SCC development plan, by 2030, the city area is expected to be 85 sq. km. If low-lying areas, ponds, and marshy land would be filled for the construction ground, then the building could be exposed to damage by a minor earthquake.

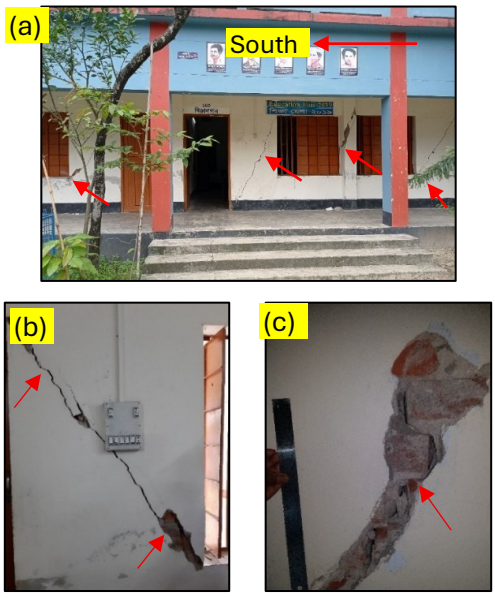

Figure 1, A series of diagonal cracks at the outside view (a) and close inside views of diagonal cracks (b) and (c) of the damaged building (Badar Uddin Ahmed Kamran building of Raja GC high school), Bandar Bazar, Sylhet.

Conclusions and recommendations

The 3.8 magnitude earthquake falling into the 3.0-3.9 magnitude range, which fits with II-III at the typical maximum modified Mercalli intensity class. This class described as people felt quite noticeably by persons at rest, indoors, especially on upper floors of buildings and many people do not recognize it as an earthquake. Events of magnitude between 3 and 4 occur frequently, but normally do not generate building damage. Therefore, there is a need for proper professional attention to low-magnitude earthquakes for reducing building damages for constructions on landfilled sites like the Sylhet region in Bangladesh. Based on field investigation and laboratory test results the following measures are recommended to reduce earthquake hazards in urban areas.

- Landfill sites without proper ground compaction or improvement should be avoided for this type of building.
- Clay materials should be avoided to select as a filling material for construction sites.
- Landfilling and ground improvement activities should be monitored by civil engineers or engineering geologists.
- Landfill sites should be totally avoided for the construction of school buildings and high-rise buildings.
- The damaged school building should be used until it is retrofitted.
- Building codes should be followed for building construction.

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