

Table 1: The distribution of geological hazards in different geologica

Environmenta

Protection

## The Status of Engineering Geology: Constraints on Infrastructure Development in Bangladesh Mir Fazlul Karim<sup>1</sup> Muhammad Qumrul Hassan<sup>2</sup> Nazrul Islam Khandaker<sup>3</sup>, Masud Ahmed<sup>4</sup> and Belal Ahmed Sayeed<sup>5</sup>

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ABSTRACT

In recent years, megacity Dhaka is known to have one of the fastest urban population growths in Bangladesh. The population in Dhaka and other megacities has increased from 7 to 50 million during the last four decades. The rapid rate of urban population growth, along with the extreme paucity of real-estate for new infrastructure development or upgrading existing facilities, is already exacerbating the situation for the city planners and exerting tremendous pressure to come-up with viable solutions. Although practice of engineering geology, geotechnical exploration, and testing exists in Bangladesh; the system has still yet to adopt controlled quality standards with unified and professionally acceptable methods. There is a dire need for accessing shallow borehole data via a central depository system in order to initiate, reassess and provide sound geoengineering recommendations for any contemplated capital construction projects. A well-coordinated system involving city agencies and private sectors can ease the situation for effecting unication regarding knowledge-sharing and keeping involved geotechnical personnel informed about already acquired data. Several development projects of the country received finance from various sources and were monitored by various agencies with prescribed methodology for execution and implementation. This diversity of funding, ownership and oversight of the projects has put the geotechnical exploration and testing system into challenging state in Bangladesh. Integration of pertinent geomorphic, regional geology, bedrock, water table and soil data will certainly aid understanding the constraints associated with any subsurface construction. Mega cities such as Dhaka and Chittagong will require intense modification in order to accommodate urban facilities, including installation of a multilevel transportation system with underground space utilization. On a positive note, the megacity of Dhaka has suitable natural ground conditions typified by sound geoengineering parameters. Standard geotechnical exploration coupled with assessment of geomorphic and geotechnical attributes will augment existing data to characterize geological materials and prepare detailed engineering/geotechnical reports to be used for design and capital construction projects. Geotechnical information from the recently completed City Water Tunnel # 3 (New York City) is considered.

Port City Chittagong

6: Near Surface Engineering Geological Map of gong City, Bangladesh (Karim, M F et al., 1990)

Dhaka Megacity

d. Waterlogging

e. Fill collaps

a Ground colla

## History of Engineering Geology in Bangladesh

The history of advancement of engineering geology in Bangladesh dates back to early seventies after the independence of the country. By the virtue of national capacity the Geological Survey of Bangladesh (GSB) led the beginning of professional practice and contribution of engineering geology in Bangladesh. Among the pioneer engineering geologists of this land the most mentionable are Mesbahuddin Ahmed, Anisur Rahman, AKM Shahidul Hasan, Hasan Faruque, Khurshid Alam, Dr Khandokar Musharaff Hossain, Dr. Sajjad Hossain and Mir Fazlul Karim. Though the concept and understanding of engineering geology existed during the early development years (before 1980) of Bangladesh, the quantification of qualitative geological information and data for engineering application was very limited as the practice of civil engineering relied on rule of thumb methods. It is being noted that Mesbahuddin Ahmed was the first engineering geologist of Bangladesh. He coauthored the seismic code for structural design engineering, through a national committee (popularly known as Committee of Experts on Earthquake Hazard Minimization of Geological Survey of Bangladesh), where the structural engineering team was led by renowned civil engineer Dr. Jamilur Reza Choudhury of Bangladesh University of Engineering and Technology (BUET). The first quantitative engineering geological input by a group of young geologists of Dhaka University Geology Department during a 1980 engineering exhibition of Bangladesh Institute of Engineers in Dhaka, sponsored by Md. Nurul Amin, an engineer of Foundation Consultants Ltd. The group

was led by Mir Fazlul Karim and other members included Dr. Arif Mohiuddin Sikder and Dr. M. Aziz Hasan. The group made a poster session and participated in the exhibition to demonstrate geological factors responsible for damaging different infrastructures in the cities. The most innovative presentation attempted to convince civil engineers and policy makers that damage to the roads of Dhaka city and surrounding regions were caused by geological factors. The postulated causes were simple and concerned the Madhupur Clay that forms the ground of Dhaka city. The Madhupur Clay is composed of swelling clays and after every rainy season the roads get bumped up with swelling heaves and troughs causing fractures in the asphalt (or tarmacs in the airports) ultimately degrading their physical condition. The engineers from the Roads and Highways adopted a significant change in the design and construction of pavement and sub-base. The underlying red soils are removed and replaced by compacted soil/sand. This practice changed the quality of roads sharply in Dhaka city since early eighties. Afterward many geologists of Bangladesh worked directly or indirectly for the advancement of Engineering Geology in Bangladesh. I would like to mention the names with due respect for their contributions. These include Dr. Badrul Imam in petroleum and mining engineering approaches, Dr. Syed Humayun Akhter in earthquake, structural and tectonics, which provided a direction for hazard assessments, Dr. Hossain Monsur for his great work in understanding of Quaternary geology that is an integral part of engineering geology, Dr. Maksud Kamal and Md. Zillur Rahman for thier great work on Dhaka city and disaster management. Simultaneously, many professional civil engineers continued to support the necessity of geological information in their design and Bangladesh Roads and Highways included the Geological Survey of Bangladesh in their design team during geotechnical investigation and design phase of first Buriganga Bridge.

Table 2: Significant geological hazards in major cities of

Figure 4: Natural

Dhaka-Tongi area.

Prepared from aeria

irface slope and

directions. All these

streams are clogged

due to urbanizati

(Karim, M F. et al

Bangladest



- Pleistocene Terraces Barind and Madhupu Old Alluvial Deposit (Chandina Alluvium 5 - Alluvial Fan Deposit 6 – Paludal Deposit, Marshy clay & pea Young Alluvial Deposit (Inter-stream deposit 8 and 9 - Deltaic and Coastal Deposit. Including Beach Estuarine and Mangrove swamp deposits

## Sall in





Along streams and depres Areas below normal flood Areas where natural draina 1&2 ods and dea Low areas with partially saturated sand/s elevation < 2 m

Swelling clays Soft to firm clay, orga 1 Mostly central or high area 2 & 3 Eastern part of Greater Dha

Generalized geology of Chittagong City Chittagong i the largest port city of Bangladesh. The engineerin geology of the city is essentially influenced by the flood plain of the Karnaphuli River, the tidal plain along the coast of the Bay of Bengal, and the undulated-to-dissected hills. The hilly area is formed of folded, soft sedimentary rocks of Mio-Pliocene age and it is the southern extension of Sitakunda Anticline. The bedrock formations are moderate to intensely fractured and faulted at a number of places. In the beginning, the city started settling mainly in the higher terrain except for a few patches of port facilities along the river mouth of Karnaphuli. Later, due to rapid increase of the urban population, the city extended into the lower alluvial and coastal plains without considering the geological aspects and constraints of these terrains. The subsurface engineering geologic conditions are strongly suitable for construction of underground tunnels and infrastructures, provided detailed bedrock engineering geology maps are prepared using standard seismic and geotechnical parameters . The city is exposed to landslide and slope instability, excavation of hills and valley fill, flash flood, soft soil, soil collapse, liquefaction, river and coastal erosion, tidal surges and flood. The geological hazards are associated with various geo-dynamic degradational and depositional geomorphological processes in this area

CONSTRAINTS ON INFRASTRUCTURE DEVELOPMENT IN BANGLADESH

gure 9: Portion of Manhattan Water Tunnel #3 (New York City) excavated by TBM (prior to 2010)

Summary

accomplishing geoengineering tasks. Knowledge of bedrock and engineering geology

and timely sharing of compiled geotechnical information with engineers, drillers,

management team and adoption of standard geotechnical exploration and testing system

key to a successful completion of the project and achieve sustainable urban

Nazrul Khandaker inspecting samples from the partially weathered zone.

development in Bangladesh

## **RIVER EROSION AND FLOOD:** CASE STUDY OF FURIOUS PADMA RIVER EROSIN IN NARIA URBAN AREA



indering and swiftly shifting braided pattern, ranging between lifferent seasons of the year which is totally dependent on discharge and runoff in the Padma River watershed including human s and control along the upstream er flow and bank erosion and ca totainy separate river was severely furious in her flow and bank erosion and caused seve d caused demolishing of hundreds of infrastructures, many villages and number of urban cen rely furious in her flow and bank erosion and caused severely like Naria Municipality in Shariatpur. During the last months of September and August., 2018 more than 4,000 families have lost their LANDSLIDE IN CHITTAGONG

homes. One renowned Bangladeshi geotechnical engineer M Humavun Kabir mentioned that failure due to hydrody amic action of the Padma river, triggered by geomorphological processes in plex geological environment, including char formation of unnel bars (Char) on the offshore of the erosion bank. Th nena of hydro-soil interaction is further aggravated by the fer foundation system of the many infrastructures in urban Naria erned geological institutes and geotechnical engineerin oup need to come forward for a detailed geological mapping estigation and geotechnical analysis of this furiou failure. The failure analysis like Naria are not studied or described in n or European text books. Present authors spe havior of the river in the coming years due to global climatic shit nd intense human interference along the ups

ADVANCEMENT IN ENGINEERING GEOLOGICAL TESTIN



ineer from Dhaka, visiting Automated Geotechnical Testin Laboratory, consisting of testing facilities for a wide range of rock and so Geology played a key role in the construction of the New York City Water Tunnel#3. parameters and properties to accommodat Sound geotechnical information not only enabled tunnel to be constructed over the testing facilities for RAJUK (Dhaka City Dev Authority). While Nancy Hubbar course of allotted time, also prevented New York City agency from encountering any demonstrates test with automate notable geotechnical disaster! Acquisition of proper geological information is extremely Resonant Column and Torsional Shea vital to any tunnel or capital construction projects in terms of resource utilization, time, Test Mir Fazlul Karim of Geocom and most importantly the welfare of personnel involved in the construction and design Corporation devoted to transfer th phase. Megacities like Dhaka and other major cities including recent start of tunnel technology to Bangladesh with keen co operation and support from Qumru construction in Chittagong are now becoming a fertile ground to test out these pivotal Hassan, Maksud Kamal, Mehdi Ansary geoengineering concepts/principles to achieve maximum effectiveness towards

Tahmeed Al Hussaini and Md Zillu Rahman (Courtesy: Gary T. Torosian Geocomp Corporation, Massachu Questions? Please contact: Mir F Karim geologist.karim@gmail.com / Dr. Nazru