# REPORT-1

## SAFER Cities Project

## COSMOS-WSSI

# INSTALLATION OF AN EARTHQUAKE MONITORING SYSTEM FOR BANGLADESH

By

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# 1 GENERAL

Earthquake is one of the most feared natural disasters which has caused incalculable destruction of properties and human lives. An examination of the historical catalogue of Bangladesh and its surrounding region reveal that several earthquakes of large magnitude with epicenters within this region have occurred in the past. The 1897 Great Indian earthquake with a magnitude of 8.7 (Oldham, 1899) is one of the strongest earthquakes in the world, had its epicenter only 230 km from Dhaka. While the earthquake affected almost whole of Bangladesh, damages were very severe particularly in Sylhet, Rangpur and Mymensingh. In the city of Dhaka most of the brick masonry buildings either collapsed or were severely damaged. The low incidence of severe earthquakes during this century has led to a situation where most of the population and policy makers don't perceive seismic risk to be important. The rapid urbanisation, development of critical engineering works, industrialisation of cities with modern types of buildings and the concentration of populations living or settling in hazardous areas are matters of growing concern, as they contribute to heavier loss of life and increase considerably the costs of disaster damage. In recognition of the threat to the major investment at risk in this part of the world from strong earthquakes, government of the respective countries should multiply and join their efforts to continue the study and analysis of the seismicity of the region with a view to reducing the earthquake risk. The first step in mitigating the risk of the community from earthquake hazard is an assessment of the hazard itself.

Macroseismic earthquake data of the large historical earthquakes are important for seismic hazard analysis. The relationship between magnitude, epicentral distance and peak ground acceleration of these earthquakes constitute the basic parameter needed for assessing seismic hazard at a given site. The purpose of this study is to present a predicting model for acceleration-attenuation for earthquakes in Bangladesh and its neighboring region.

# 2 OBJECTIVES

During the last two centuries, Bangladesh and its neighbouring region have experienced several large earthquakes. The peak ground acceleration of these earthquakes has been estimated using different existing attenuation laws for different parts of the world. The

current research is one opportunity to develop our own attenuation law, but we need to collect earthquake data for the next few years.

The objective of the study is to install a seismic network system to record earthquakes, which may occur within any location of Bangladesh and surrounding region. The seismic network system will specifically help to achieve the following:

- To obtain strong motion data which can be used to update BNBC 1993
- To obtain building response during an earthquake
- To compare free-field and building earthquake responses
- To develop attenuation law for Bangladesh
- To use collected data for realistic earthquake hazard assessment
- To exchange earthquake data with neighboring countries

## 3 OUTLINE OF METHODOLOGY

The motion of the ground during earthquakes is measured by instruments called strong motion accelerographs; the records of ground acceleration versus time produced by accelerographs are called accelerograms. Accelerograms provide a description of the ground motion in a form suitable for analysis of structural response and, hence, they play a fundamental role in the study of all phases of earthquake engineering.

The sixty accelerographs recently obtained from SAFER cities project of COSMOS-WSSI will be mainly deployed in the free-field (on ground) at different locations of Bangladesh. Also some of the accelerographs will be put on buildings to get their response during an earthquake. Bangladesh PWD has agreed to provide spaces in their offices all over the country *(see attached PWD circular dated 14.12.04*). For free-field deployment concrete pads need to be placed on the ground at those selected stations and accelerographs will be directly bolted on them.

The initial goal of the project is to develop an earthquake time history database for different soil condition and different earthquakes of Bangladesh. After compilation of a number of earthquakes, this database will be used to develop attenuation law for Bangladesh. This database can also be used to develop site-specific response spectra for different damping conditions. Ultimately the data will be used to update the seismic zonation map of Bangladesh.

## 4 DESCRIPTION OF INSTRUMENT

Data processing is always facilitated by a thorough knowledge of the instrumentation, which has produced the basic information. Acceleration due to earthquake may be collected through an instrument known as **Strong Motion Accelerographs** (SMA-1).

Figure 1 is a schematic diagram of the basic transducer system in the type of mechanical-optical photographic recording accelerograph, which produces the records. Although details may differ considerably in various models, the general ideas are much the same. The single degree-of freedom transducer element usually consists of some from the "swinging gate" mass, with either a torsional spring or a gravity restoring force produced by including the hinge axis of the gate. The detail in the lower left corner of Fig. 1 indicates that in many models the axis of rotation is fixed by some type of flexure pivot, and that the viscous damping is often the electromagnetic type involving motion of a coil in a permanent magnet field. Amplification of a transducer motion is usually carried out optically as indicated, with a light source and a system cylindrical lenses and prisms to focus the light spot on the recording medium.

A typical strong motion accelerograph will contain three transducer components of the type shown in Fig. 1 recording on one film, along with associated timing and calibration circuits, controlled speed drive for the recording drum, and a suitable power supply. Figure 2 shows photograph of the SMA-1 accelerograph.

## 5. FOUNDATION AND SECURITY

Accelerographs, which are supplied to this specification, shall be battery powered; rugged; compact, portable and transportable over rough terrain by vehicle; and then capable of being installed and calibrated with a minimum of adjustment. After installation, the accelerograph shall remain in a standby condition with infrequent maintenance until acquated manually or by strong ground motion. The accelerograph shall be capable of recording numerous earthquakes on photographic film.

### 5.1 Base casting /Foundation for SMA Instrument

At first, the location of the SMA instruments is selected. The Strong Motion Accelerograph must be situated on the ground surface. The soil condition must be dense sand/stiff clay. The trench size is 3.5ft x 3.5ft x 1.5ft. In the sand filling and brick flat soling (B.F.S) is 1.5ft and finally Concrete Base-1 Foundation Casting size is 3.0ft x 3.0ft x 0.5ft and RCC casting ratio is 1: 2: 4 and in another base casting size is 1.5ft x 1.5ft x 0.5ft. Figure 3 shows the concrete base for the SMAs.

### 5.2 Protections and Identify of SMA-station

Iron grill fencing is put around the SMA-Instrument and the top surface is protected with Galvanized steel sheet. To identify the SMA-Instrument a nameplate is set-up. Location names, Serial No, Date of Installation, are written on the nameplate.

## 6. GEOLOGY OF THE STUDY AREA

More than 80% of Bangladesh is underlain by quarternary sediments consisting of deltaic and alluvial deposits of the Ganges, Brahmaputra and Meghna rivers and their numerous tributaries. According to the study of Morgan and McIntire (1959), there are two major areas of Pleistocene sediments, commonly known as Madhupur tract and Barind tract. The Madhupur block lies between the Jamuna and Old Brahmaputra rivers and 6 to 30 m above the mean sea level. Madhupur tract is bounded by faults; they appear to be uplifted and structurally complex; the Madhupur block has been tilted eastward (Morgan and McIntire, 1959). Figure 4 shows the Geological map of Bangladesh.

## 7. SMA LOCATIONS

Figure 5 shows the location map and Table 1 presents the basic data for the SMA stations. Also Figs. 6 to 26 show the installed SMAs.

**Table: 1 Location of SMA instruments in Bangladesh**

| Sl. no. | ID no./ M/SL-No | Station no. | Location | Address |
|---|---|---|---|---|
| 1. | MSL-5868 | BUET-1 | In front of Civil Building, BUET, Campus Dhaka | Dr. Mehedi Ahmed Ansary<br>Dept. of Civil Engineering, BUET, 5th Floor, Room No-644, Phone 9665650, Ext: 7627; Fax: 880-2-9665639<br>Email: ansaryma@yahoo.com<br>or ansary@ce.buet.ac.bd<br>Mobile: 0171343288, 0191394030, 0152357651 |
| 2. | MSL-4378 | BUET-2 | Civil Building 6th Floor, BUET Campus, Dhaka. | Dr. Mehedi Ahmed Ansary<br>Dept. of Civil Engineering, BUET, 5th Floor, Room No-644, Phone 9665650, Ext: 7627<br>Fax: 880-2-9665639<br>Email: ansaryma@yahoo.com<br>Or ansary@ce.buet.ac.bd<br>Mobile: 0171343288, 0191394030, 0152357651 |
| 3. | MSL-6144 | BUET-3 | Teacher's Quarter 11/F, BUET Campus | Dr. Mehedi Ahmed Ansary<br>Dept. of Civil Engineering, BUET, 5th Floor, Room No-644, Phone 9665650, Ext: 7627; Fax: 880-2-9665639<br>Email: ansaryma@yahoo.com<br>Or ansary@ce.buet.ac.bd<br>Mobile: 0171343288, 0191394030, 0152357651 |
| 4. | MSL-1489 | BUET-9 | Kishorganj | Executive Engineer PWD<br>Old Judge-Court, PWD Office, Kishorganj<br>Phone No: 0941-55351 |

| Sl. no. | ID no./ M/SL-No | Station no. | Location | Address |
|---|---|---|---|---|
| 5. | MSL-2261 | BUET-10 | Netrokona | Executive Engineer PWD<br>Old Judge-Court, Police line, PWD Office, Netrokona<br>Phone No: 0951-61588 |
| 6. | MSL-5859 | BUET-11 | Sherpur | Executive Engineer PWD Kharumpur, C & B Mohr, PWD Office, Sherpur<br>Phone No: 0931-61481 |
| 7. | MSL-0529 | BUET-12 | Jamalpur | Executive Engineer PWD<br>Surovi Cinama hall, C & B Mohr, PWD Office, Jamalpur<br>Phone No: 0981-63666 |
| 8. | MSL-2550 | BUET-13 | Bandarban | Executive Engineer PWD<br>Sadar Hospital Mohr, (DC Office) PWD Office, Bandarbhan<br>Phone No:0361-62533 |
| 9. | MSL-1461 | BUET-14 | Chittagong (Rahmatganj) | Executive Engineer PWD<br>PWD Office, Rahmatganj. Chittagong.<br>Phone No:031-616028 |
| 10. | MSL-5440 | BUET-15 | Chittagong (Agrabad) | Executive Engineer PWD<br>PWD Office, CG-Building. Agrabad, Chittagong<br>Phone No:031-726161 |
| 11. | MSL-5850 | BUET-16 | Cox's Bazar | Executive Engineer<br>PWD PWD Office, Light house, Sea-beach, Cox's Bazar<br>Phone No:0341-63547 |
| 12. | MSL-1582 | BUET-17 | Rangamati | Executive Engineer PWD<br>Rupganj, PWD Office, Rangamati<br>Phone No:0351-62103 |
| 13. | MSL-1718 | BUET-18 | Khagrachari | Executive Engineer PWD<br>DC Office, Shapla-chattar, PWD Office, |

| Sl. no. | ID no./ M/SL-No | Station no. | Location | Address |
|---|---|---|---|---|
| | | | | Khagrachari.<br>Phone No:0371-61643 |
| 14. | MSL-4813 | BUET-19 | Sylhet | Executive Engineer PWD<br>PWD Office, Taltola, Sylhet.<br>Phone No:0821-716231 |
| 15. | MSL-1719 | BUET-20 | Sunamganj | Executive Engineer PWD<br>Hazipara, DC-office, Police line, Sunamganj.<br>Phone No:0871-55409 |
| 16. | MSL-4857 | BUET-21 | Hobiganj | Executive Engineer PWD<br>PWD Office, Police line, Hobiganj.<br>Phone No:0831-52571 |
| 17. | MSL-4377 | BUET-22 | Moulvi-bazar | Executive Engineer PWD<br>PWD Office, Sahjalal Road, Moulovi-bazar<br>Phone No:0861-52287 |
| 18. | MSL-0813 | BUET-24 | Sathkhira | Executive Engineer PWD<br>Rajib Super Market, Hatbazar Mohr, PWD Office, Sathkhira<br>Phone No: 0471-63657; 0471-63224 |
| 19. | MSL-1455 | BUET-25 | Meherpur | Executive Engineer PWD<br>Meherpur, Bus Stand Bazar, PWD Office, Mehepur<br>Phone No: 0791-62422, 62316 |
| 20. | MSL-1464 | BUET-26 | Panchagarh | Executive Engineer PWD<br>Circuit House, PWD Office, Panchagarh<br>Phone No: 0568-61250, 61227 |
| 21. | MSL-1829 | BUET-27 | Gaibandah | Executive Engineer PWD<br>V-H, Road, Banglabazar<br>PWD Office, Gaibandah |

| Sl. no. | ID no./ M/SL-No | Station no. | Location | Address |
|---|---|---|---|---|
| | | | | Phone No: 0541-61578; 61488 |
| 22. | MSL-2509 | BUET-28 | Kurigram | Executive Engineer PWD Office Para, PWD Office, Kurigram<br>Phone No: 0581-61435, 61503 |
| 23. | MSL-1473 | BUET-29 | Dinajpur | Executive Engineer PWD Station Bazar, DC Office,<br>Dinajpur PWD Office,<br>Dinajpur.<br>Phone No: 0531-65129, 65050 |
| 24. | MSL-1626 | BUET-30 | Chapai - Nawabganj | Executive Engineer PWD<br>PWD Office, Judge-Court, Chapai – Nawabganj.<br>Phone No:0781-62067 |
| 25. | MSL-5857 | BUET-31 | Nilphamari | Executive Engineer PWD<br>Bus Stand Bazar,<br>PWD Office, Nilphamari<br>Phone No: 0551-61323, 61325 |
| 26. | MSL-1591 | BUET-32 | Rangpur | Executive Engineer PWD<br>Kachari-bazar, Old Judge-Court, PWD Office, Rangpur<br>Phone No: 0521-62124, 62924 |
| 27. | MSL-2770 | BUET-33 | Lalmonirhat | Executive Engineer PWD<br>Circuit House, Old Judge-Court, PWD Office, Lalmonirhat<br>Phone No: 0591-61333, 61763 |
| 28. | MSL-1493 | BUET-34 | Comilla | Executive Engineer PWD, Near BWDB office, Comilla<br>Phone No: 081-76935 |
| 29. | MSL-6095 | BUET-35 | B. Baria | Executive Engineer PWD, In front of DC office, B. Baria<br>Phone No: 0581-52473 |

| Sl. no. | ID no./ M/SL-No | Station no. | Location | Address |
|---|---|---|---|---|
| 30. | MSL-1222 | BUET-4 | Prime Minister's Office | Executive Engineer, Division-2, Segunbagicha Dhaka<br>Phone No: 9556184, 0189-207128 |
| 31. | MSL-0826 | BUET-5 | Segunbagicha | Executive Engineer, Division-4, Segunbagicha Dhaka<br>Phone No: 9557108 |
| 32. | MSL- | BUET-6 | Hazi Camp, ZIA (to be deployed) | Executive Engineer, Mohakhali Division, Dhaka<br>Phone No: 9890515 |
| 33. | MSL- | BUET-7 | Mirpur (to be deployed) | Executive Engineer, Mirpur Division, Dhaka<br>Phone No: 9002859, 8120792 |
| 34. | MSL- | BUET-8 | Segunbagicha (to be deployed) | Executive Engineer, Division-3, Segunbagicha Dhaka<br>Phone No: |

## 8. CONCLUSIONS AND RECOMMENDATIONS

Already BUET has installed 31 SMAs in different district PWD offices of Bangladesh. In addition we have 7 digital accelerograph stations in two sides of Jamuna Bridge. We have already calibrated the SMAs by recording data on the film by bolting a SMA on the indigenous Shaking Table, which we have installed at the Concrete Laboratory of BUET, which has been officially inaugurated by the Hon. VC of BUET on January 8, 2006. So the process of digitization of data from photographic film has also been done. Now we are waiting for a strong ground motion to be generated by a moderate earthquake anywhere in Bangladesh. For the next few years we need to record such earthquake data to develop the attenuation law for Bangladesh. This attenuation law will help us to develop the seismic zonation map for Bangladesh.

**References**

BNBC (1993). Bangladesh National Building Code, HBRI-BSTI.

KMI User's Manual (1997). SMA SCANVIEW PLUS - scanner-based software for film accelerogram digitization.

Morgan, J. P. and McIntire. (1959). Quaternary geology of Bengal basin, East Pakistan and India, Bulletin of Geological society of America, Volume 70, pp. 319-342.

Oldham, R.D. (1899). Report on the Srimangal Earthquake of 12$^{th}$ June 1918, Memoir of Geological Survey of India, Volume 29, pp.1-349.

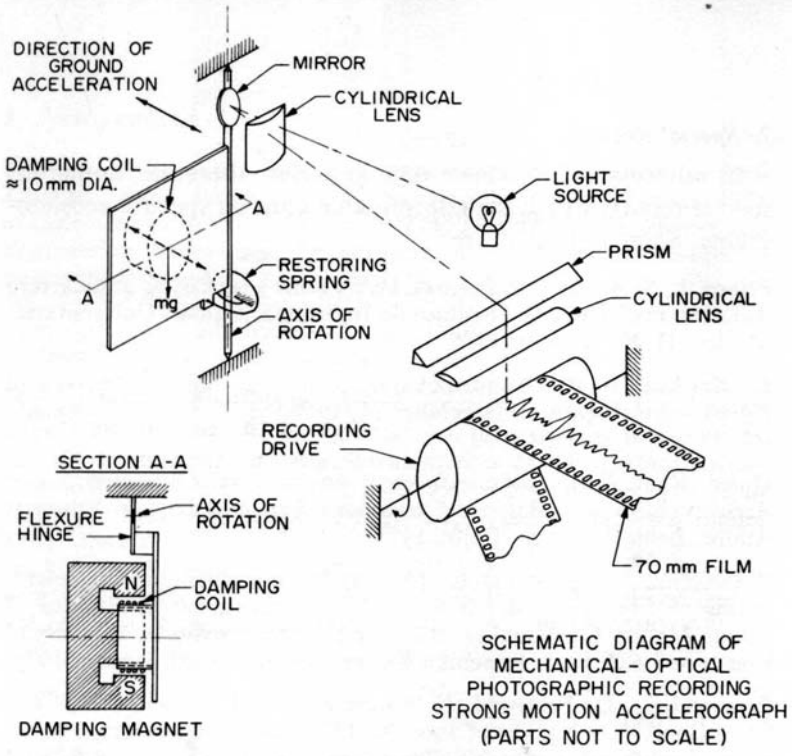
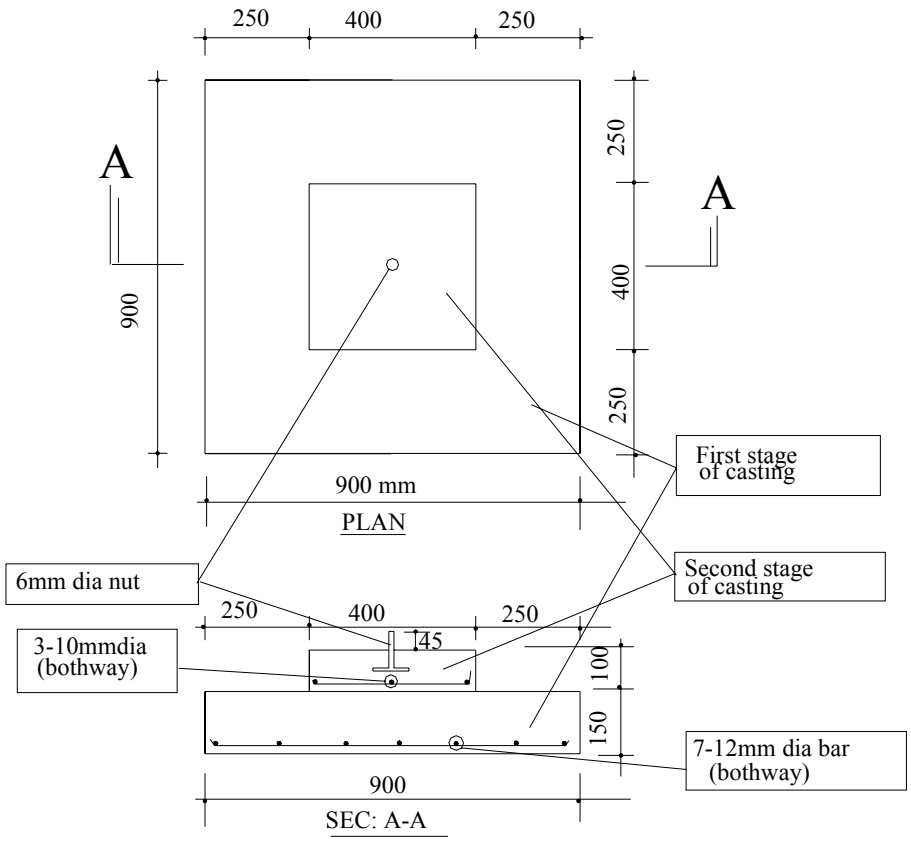



Figure 1

**Figure 2** hotograph of SMA-1 Strong Motion Accelerograph




NOTE: Alldimensions are in mm.

**Figure 3 Concrete Base Foundations for SMA-Instrument**

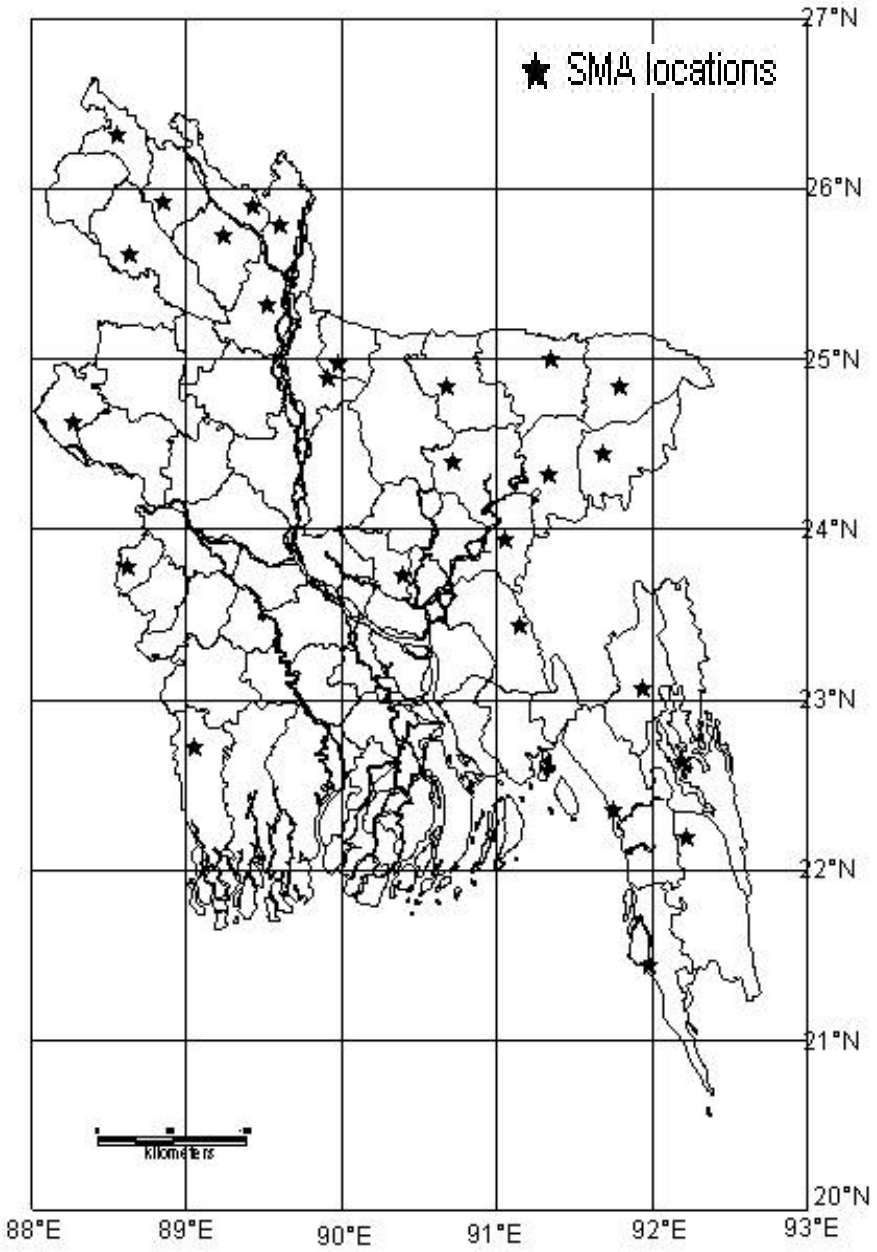



**Figure 4. SMA-Location map of the study area**

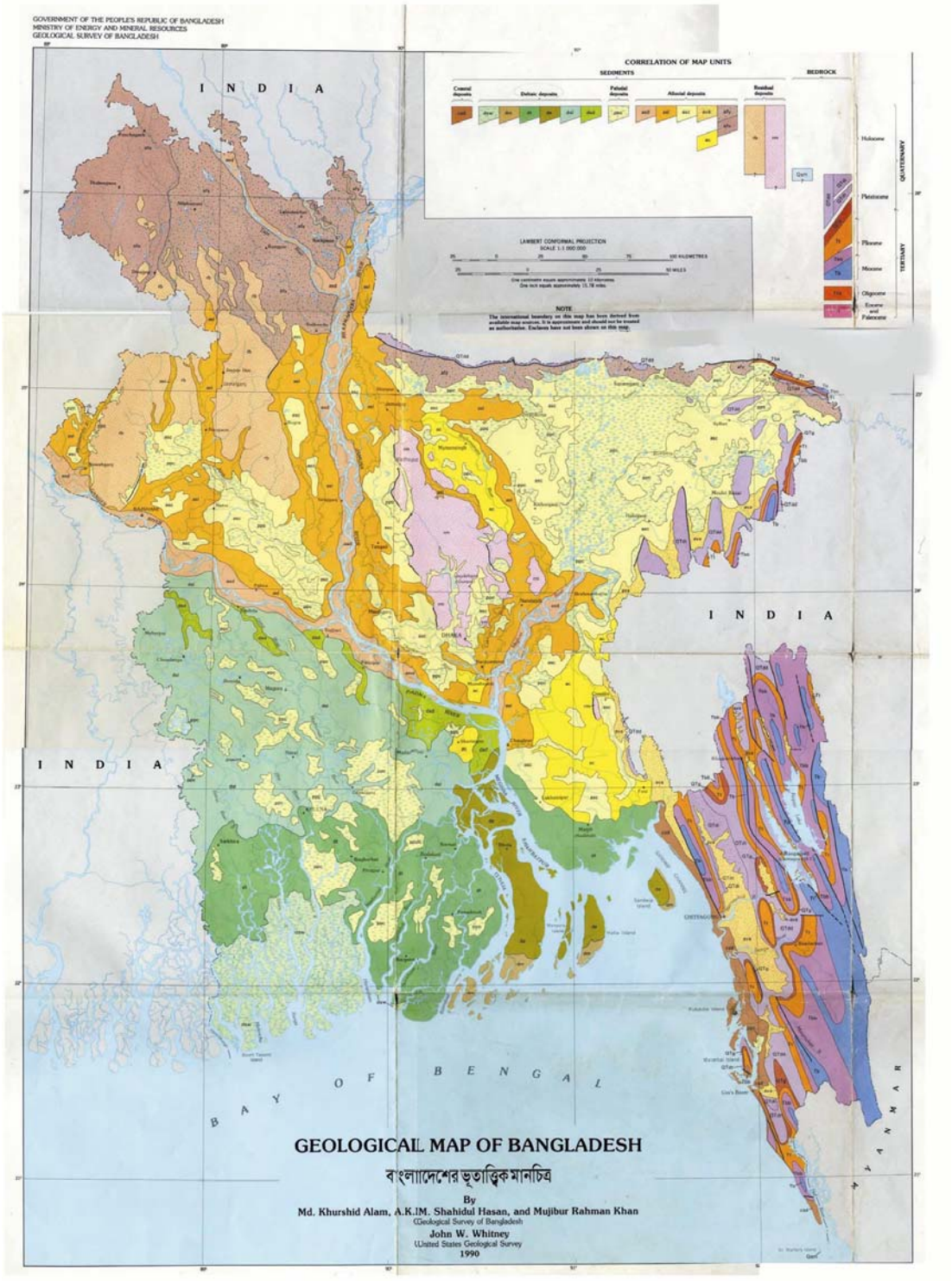



**Figure 5. Geological map of Bangladesh**

**Figure 6. SMA at Civil Building Ground, BUET**


**Figure 7. SMA at top floor, Civil Building, BUET**


**Figure 8. SMA at top flloor, Teacher's Apartment Block, BUET**

**Figure 9. SMA at Khagrachari**

**Figure 10. SMA at Khagrachari (Machine's picture)**

**Figure 11. SMA at Rahmatganj, Chittagong**

**Figure 12. SMA at Bandarbhan**

**Figure 13. SMA at Rangamati**


**Figure 14. SMA at Hobiganj**


**Figure 15. SMA at Moulovibazar**

**Figure 16. SMA at Sunamganj**

**Figure 17. SMA at Sylhet**


**Figure 18. SMA at Satkhira**


**Figure 19. SMA at Meherpur**


**Figure 20. SMA at Panchagarh**


**Figure 21. SMA at Dinajpur**

**Figure 22. SMA at Gaibandha**


**Figure 23. SMA at Kurigram**


**Figure 24. SMA at Nilphamari**


**Figure 25.SMA at Rangpur**


**Figure 26. SMA at Lalmonirhat**

**Appendix: PWD Circular**