# バングラデシュにおける河川堤防の性能と維持管理について
(Performance and Maintenance of River Embankments in Bangladesh)

○座狩屋　保世院*, 酒井　俊典*
○Zakaria Hossain*, Toshinori Sakai*

**Introduction:** Construction of earthen embankments, their repairing and rebuilding for flood control, irrigation and drainage have been the history of Bangladesh since time immemorial. Over the last few decades, more than 13000 km of earthen embankments have been constructed because of their cheapest form to protect people's health, homes, agricultures and city dwellers from flooding. It is evident that the earthen embankments in Bangladesh are overwhelmed with multi-facetted problems. These are not only unsuccessful to serve the purpose for which they are constructed but also create many other new problems. Usually the earthen embankments are breached easily due to rainfall splash, animal actions and the human interferences. The failure of embankments in Bangladesh is almost a recurring phenomenon and thus, continuing every year. In 2007, a lot of earthen embankments, river banks, agricultural and forest land on terraces and hill slopes are subjected to erosion just at the start of the monsoon (**Fig.1**). Although the failure of embankment is very common news in Bangladesh, unfortunately very little or no study is available that has been adequately analyzed the main reason of such failure. To minimize the impact of natural disasters as well as to achieve the aim of embankment construction in Bangladesh, sustainable and cost-effective operation for maintenance of these embankments is utmost necessary. For the interest of the overall economy of embankment construction and environmental conservation in Bangladesh, a research project is undertaken in the Division of Environmental Science and Technology, Mie University. The present research article reports the results of an investigation into the causes of damages of some flood embankments in Bangladesh in order to make possible remedial measures to reduce the embankment failure in the country. Jamuna embankment at Bogura and Padma embankment at Rajbari is taken into consideration for a detailed study in this research article as there was severe damage in the year 2007 (**Fig.2**).

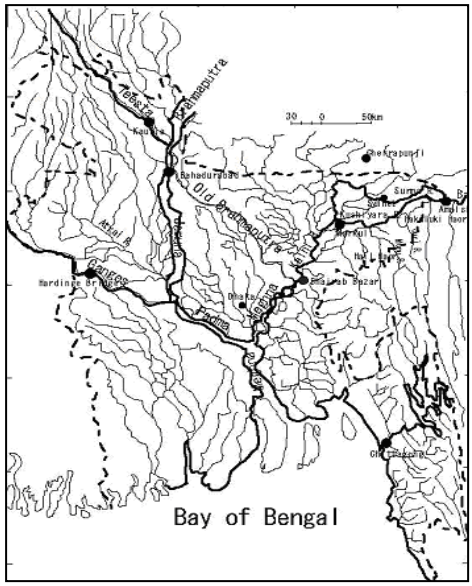


**Fig.1** Rivers and embankments

**Fig.2** Embankments failure

**Field Visit and Data Collection:** Various types of information on embankment failure such as geometry, soil conditions, river position, flood water levels, construction procedure, materials used, hydraulic and hydrologic condition are collected from different sources for instance, local people of the areas of embankment failure, officials of BWDB, contractor connected to the design and construction of the embankments. To understand the physical properties of the embankment materials, samples from the failed location are collected and analyzed. The cross-sections of the embankments are drawn in order to investigate the geometry of the failed embankments, stability of slopes and other parameters. The analyses of stability of the failed embankments are performed by the determinate method because of its ease in calculation, accuracy and handiness in application to the field with and without water storage conditions.

**Results and discussions:** Some of the recent failures of embankments, name of the regions, location of failure, name of the embankments and date of breached are summarized in Table 1 and Table 2 in monthly basis for the year of 2007, respectively. It is evident that most of the embankments are failed in the month

＊　三重大学生物資源学研究科, Graduate School of Bioresources, Mie University; 「バングラデシュ，河川堤防，土質特性、崩壊、機能、維持管理、安定解析、」

of May and June, the months which are the start of monsoon of the year 2007. Among 6 cases reported in this paper, two embankments are failed in May and another four embankments are failed in June indicating that the failure of the embankment increases with the increase of rainfall and thrust of river water current. It is observed from this table that a lot of damages such as lives, land, agriculture, roads, houses and fisheries are occurred in 2007 during just two months period indicating continuous disruptions and damages due to failure of many embankments and effect of floods. Some of the physical properties of soils of the failure locations of Jamuna and Padma river embankments are depicted in Table 3. The coefficient of permeability of soil of the failed sections of Jamuna and Padma river embankments are obtained as $0.35\times10^{-6}$ and $0.42\times10^{-6}$ cm/sec, respectively.

Table 1. Embankments breached in 2007

| Name of Embankment and location | Date of breach | Damages |
|---|---|---|
| Jamuna embankment, Bogura | May 2 | Over 1,50,000 families have been affected |
| Baufal Embank-ment , Patuakhali | May 18 | 12 villages flooded and 2000 acres land damaged |
| Cross Dams, Teknaf | Jun 5 | Damages 150 houses, 40 fishermens |
| Gabtoli , Dhaka | Jun 11 | Connecting road damaged |
| Khosbari , Sirajgonj | Jun 13 | Nearly 1200 meters breached |
| Rajbari, Rajshahi | Jun 16 | Nearly 50 km has been damaged |

The dry density, specific gravity, optimum water content and angle of internal friction of both soils are given in Table 3. The particle size distribution data given in this table showed that the soil of Jamuna dam consists of 58% sand, 44% silt and 8% clay, and the soil of the Padma river embankment composed of 44% sand, 43% silt and 13% clay indicating that both the soils can be classified as non-plastic SC group according to the unified classification system. On the basis of the properties of soils obtained, it can be said that the soils are fairly suitable for embankment construction according to the Indian Standards. However, the soils are also suitable to move easily with the impact of rain splash and current of water if it expose to rain and river flow without any surface protection or reinforcement.

Table 2. Properties of soils of embankments.

| Soil Properties | Jamuna dam, Bogra | Padma dam Rajbari. |
|---|---|---|
| Dry density, $t/m^3$ | 01.38 | 01.43 |
| Optimum water content, % | 14.30 | 13.50 |
| Specific gravity | 02.63 | 02.64 |
| Cohesion, $kN/m^2$ | 05.71 | 06.35 |
| Angle of internal Friction, degree | 18.21 | 16.32 |
| Sand, >75$\mu$m ( % ) | 58.00 | 44.00 |
| Silt, 5-75$\mu$m ( % ) | 44.00 | 43.00 |
| Clay, <5$\mu$m ( % ) | 08.00 | 13.00 |
| UCS classification | SC | SC |

Recent floods in 2007 caused many failures of embankments and river banks, and damaged a lot of things along with deaths of many peoples in just two months. This is because the country usually tried to deal with the short term consequences of flood and embankments. However, in order to cope with the persistent situation of flood and consequences of embankment failure, Bangladesh has to think seriously about the long-term strategy regarding the flood control procedure and embankments construction methods. In **Fig.3**, it can be observed that the sand filled geotextiles bags are used in some places along with geotextiles carpeting on the river bank and embankment. During filed visit it was observed that these geotextiles bags and carpeting were mainly implemented for immediate or emergency protection to save the acute bank erosion problem when the embankment was on the way of failure. Many of the bags were not properly positioned due to the excessive trust of water velocity during the peak river flow. This clearly indicates the alertness and awareness of government but necessary steps in this direction especially for long tern protection of earthen embankment from failure should be taken into account urgently.

**Fig.3** Geobags for bank protection

**Conclusions:** The cause of failure of all the flood control embankments in the year 2007 could be attributed to erosion and sliding of embankments materials due to river encroachment and mitigation. Sand filled geotextiles bags and carpeting are used to protect the embankment from failure especially during the peak seasons flow. Concrete blocks are also used at some locations. Proper planning for long term stability needs to be taken into consideration to implement the geotextiles in timely manner.