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COMPARATIVE STUDY ON THE ENGINEERING PROPERTIES OF LOCALLY AVAILABLE BRICKS & SAND IN EASTERN REGION OF CHITTAGONG

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ABSTRACT
Bricks & sand are used in various types of construction work such as partition wall, reservoir, road & building. Problems frequently occur due to the use of low-quality bricks & sands. Bricks & sand that do not fulfil the quality standards make structures weak & faulty. Different field and laboratory tests are needed for quality control of these engineering materials. This study covers the experimental investigation sand and brick samples collected from ten different local areas of Chittagong district. These materials were tested through field and laboratory tests to assess their engineering properties in order to compare with standard limiting values. Unit weight, Fineness modulus, Salinity, Water Absorption Capacity, Specific gravity and Chloride tests were conducted for sand. Whereas Field Test, Size & Shape, Salinity, Chloride, Unit Weight, Water Absorption and Crushing Strength tests were performed for Bricks in the laboratory of Chittagong University of Engineering and Technology. The properties of brick and sand samples are observed to vary for different sources. However, the test data may provide necessary information to ensure quality of construction works in this region.

Keywords: Bricks; Sand; Engineering properties; Laboratory test; Field test

INTRODUCTION
Soil is the upper layer of earth containing inorganic particles and organic substance covering most of the land surface. Sand has been defined as a loose granular substance and various organic matter having liquid and gas in the empty space between the soil particles. Soil is also considered to be harsh grained particle with particle size between 0.07 mm to 4.75 mm (Lambee, 1951) and is an engineering material that plays a significant part in civil engineering works. Soils vary mostly in their chemical and physical properties depending on their age and states (parent material, climate, topography and vegetation) under which they are shaped. The major component of the most soils is inorganic material. It comprises mostly of mineral particles having particular physical and chemical properties that differ on the basis of the parent material conditions under which the soil was formed. The texture of soil is a feature that is ascertained mostly by the relative ratio of inorganic particles of various sizes. Grit particles are larger than 2mm in diameter, frieze sand-particles less than 2 mm and larger than0.2 mm in diameter, fine sand-particles are either 0.2mm or 0.02mm in diameter, spilt-particles between0.02 mm and 0.002 mm in diameter (Das and Sobhan, 1998). Quartz is the remarkable mineral in the sand fraction of a large number of soils. On the other hand, sand particles have a relatively small surface area per unit weight, less water retention with little chemical activity in comparison with silt and clay. So, it is essential to know about physical and chemical properties of soil so as to know whether the soil is chemically active or not (Zaman and Islam, 2010). Soil engineering has wide application in the construction of different civil engineering structure like foundations, retaining structures, stability of

slopes, underground structures, pavement design, earth dam etc. The properties defining sand as standard quality would be well graded, coarse and clean, free from all types of detrimental substances, and does not contain any uncleanliness like iron pyrite acidic and basic, mica etc.

Meanwhile, Brick is the small building material in the form of a rectangular block which was first produced in a sun-dried from at least 6,000 years ago. Clay is the basic component that is mined from open pits, formed, and then fired in a kiln in order to produce strength, hardness, and heat resistance. Brick was the major building material in the ancient Near East and its multi-dimensionality was extended in shale ancient Rome by developments in manufacture and by new techniques of bonding. Little amounts of manganese, barium, and other additives are mixed with the clay to produce various shapes and barium carbonate is used to develop brick's chemical resistance to the components. Many other additives such as byproducts from papermaking, ammonium compounds, wetting agents, flocculants causing particles to form loose clusters and deflocculants dispersing clusters have been used in brick and some clays need the addition of sand or grog (pre-ground, pre-fired material like scrap brick). Various types of coating materials and procedures are needed to produce brick of a certain color or surface texture. The flux lowers the melting temperature of the sand in order to be bonded to the brick surface. There are some other materials such as graded fired and unfired brick, nepheline syenite and graded aggregate can also be used. The primary step in producing brick is crushing and grinding the raw materials in separator and a jaw grinder. Then, the mixture of components desired for each particular batch is selected and filtered before it was sent on to one of the three brick shaping processes. They are extrusion, molding or pressing. Among the three processes the first one is the most adaptable and it is the most common. Once the bricks are shaped and they are dried to remove excess moisture which may cause cracking during the ensuing firing process. Firing in ovens and then cooling, they are detached-automatically stacked, wrapped with steel bands and padded with plastic corner protectors. The bricks which are used in construction works are burnt bricks. They are classified as the first-class bricks, second class bricks, third class bricks and fourth-class bricks. So, the optimum properties which make quality bricks are well burnt with copper colored. They are free from cracks having square and sharp edges. They produce audible metallic sound at time of struck. These types of bricks absorb minimum water when they are submerged in water. These bricks do not break although they are dropped from 1-meter height (Aziz, 1995). The main objectives of this study are to assess the quality of the locally available bricks and sand by field test and relevant laboratory tests. Thereafter the properties of brick & sand will be compared with standard value.

EXPERIMENTAL PROGRAM

Materials used

Sand

Sand samples were collected from the following areas: Karnaphuly (bahirerchor), CUET balurchora, Shilok sand, Karnaphuly river (vitorerchor), Modunaghat, Bangalkhali, Tarabuniar chora, Ranir hat, Ichamoti river, Raojankhal.

Brick

Bricks samples were collected from different brick fields of Raozan and Rangunia Upazila. The various frog marks were BBC, SBM, EBM, FM, BBM, MBI, KBM, MBM, BBI, PBM. For each source sample No.1 (first class), No.2 (second class) and No.3 (picket) were collected.

Test conducted

Sand

The following laboratory tests were performed to asses the quality of the collected sand sample. Standard test procedure (ASTM C29, ASTM C128-15, ASTM C136, ASTM D1411-09) were followed for the relevant test:

- Sieve Analysis
- Specific Gravity
- Unit Weight
- Salinity
- Chloride

Bricks

The various tests were performed in the laboratory according to relevant standard procedure (ASTM C67 / C67M-18):

- Compressive Strength
- Water Absorption
- Unit Weight
- Efflorescence Test
- Field Test of Brick

RESULT AND DISCUSSION

As stated earlier, brick and sand samples were collected from the locally available sources. For each test, average of at least 03 samples test results were taken. The test results are shown in graphical and tabular forms. Fig. 1 to Fig. 5 shows the F.M., unit weight, specific gravity, chloride content and salinity respectively of sand samples collected from various sources. Also, Table 1 shows the comparison of results with the standard values. On the other hand, Fig. 6 to Fig. 10 show the crushing strength, salinity, unit weight, water absorption and chloride content respectively of brick samples collected form different brick fields. Likewise, Table-2 shows the brick field test results. Also, Table 3 shows the comparison of results with standard values for brick samples. From the Figures and tables, it is seen that engineering properties of the brick and sand samples vary form source to source. However, after detail analysis of the test results, a few conclusions and recommendations are made therefrom.

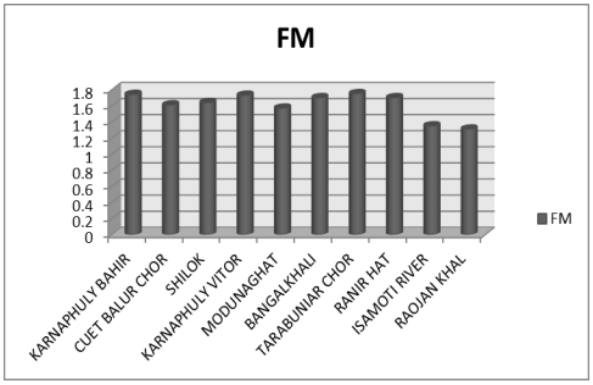

Fig. 1: Fineness Modulus of Sand

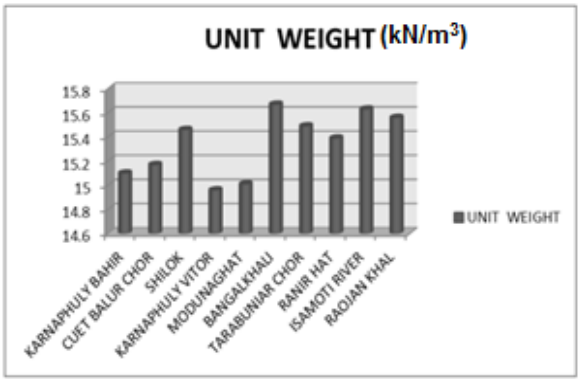

Fig. 2: Unit Weight of Sand

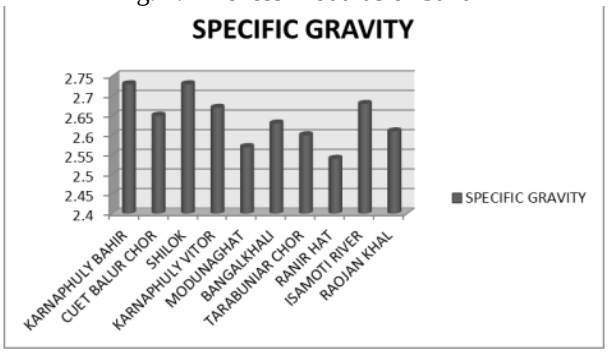

Fig. 3: Specific Gravity of Sand

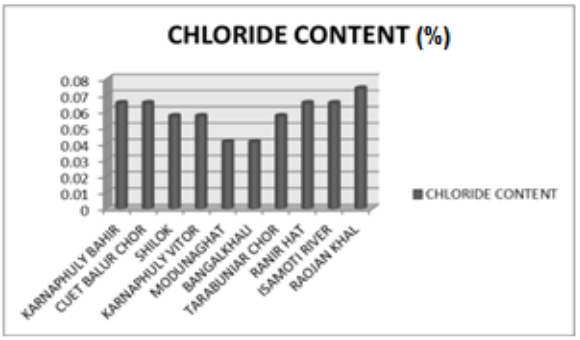

Fig. 4: Chloride Content of Sand

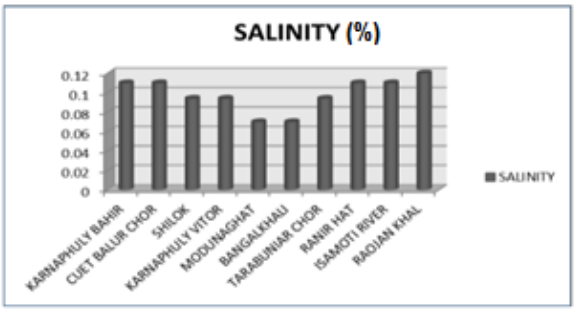

Fig. 5: Salinity Content of Sand

Table 1: Comparison of Results with Standard values (Sand)

Parameters	Results	Standard Values
Fineness modulus	1.57-1.74	2.3-3.1
Specific gravity	2.54-2.73	2.65-2.68
Unit weight	14.97-15.67	14-19
Salinity	0.072-0.12	0.074-.099
Chloride content	0.042-0.07	0.045-0.060

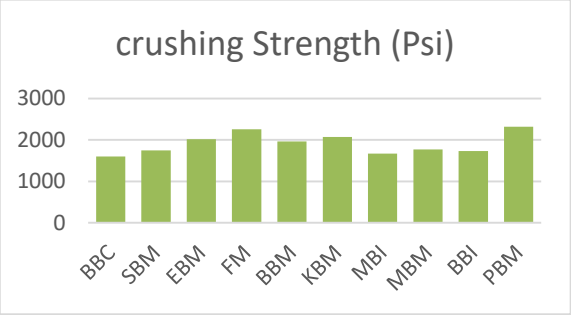

Fig. 6: Crushing Strength of Bricks

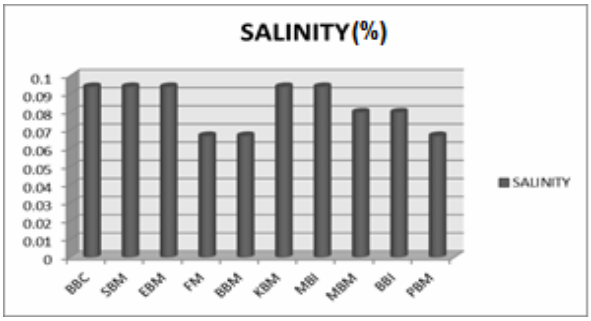

Fig. 7: Salinity of Bricks

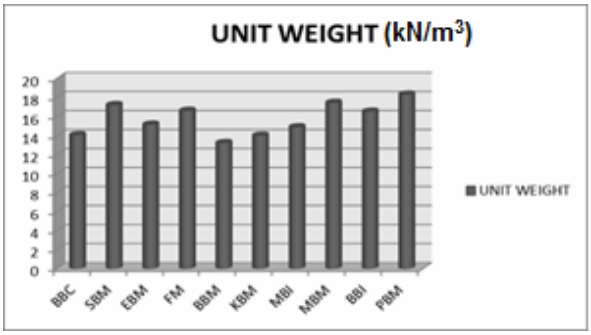

Fig. 8: Unit Weight of Brick

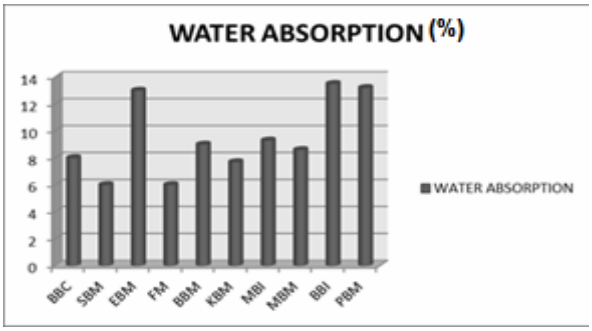

Fig. 9: Water Absorption of Brick

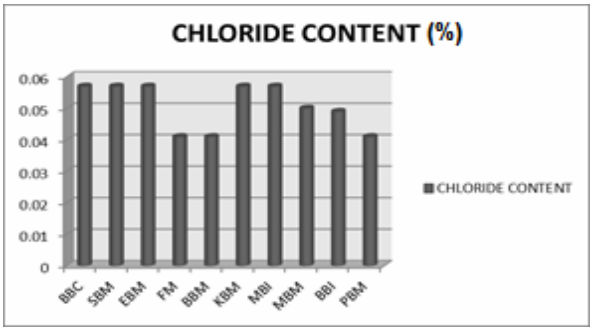

Fig. 10: Chloride Content of Bricks

Table 2: Field test of brick

Test Name	Sample	BBC	SBM	EBM	FM	BBM	KBM	MBI	MBM	BBI	PBM
T-Test	1	S	S	S	S	S	S	S	S	S	NS
	2	NS	S	S	S	S	NS	S	NS	NS	S
	3	NS	S	NS	S	S	S	NS	S	S	S
Nail Test	1	S	S	S	S	S	S	S	S	S	NS
	2	NS	NS	S	S	S	NS	S	S	S	S
	3	NS	S	NS	S	S	S	NS	S	S	S
Sound Test	1	S	S	S	S	S	S	S	S	S	S
	2	S	S	S	S	S	S	S	NS	S	S
	3	NS	S	S	S	S	S	NS	S	S	S

* S- satisfactory; NS- not satisfactory

Table 3: Comparison of Results with Standard values (Brick)

Parameters	Results	Standard Values
Field test	Satisfactory	
Unit weight (kN/m^3)	13.22-17.46	18.84
Water absorption (%)	0.06- 0.21	15-20
Salinity (%)	0.067-0.094	
Crushing strength (psi)	1600-2400	

CONCLUSIONS

In this study, samples of brick & sand from ten different sources of sand & brick fields were collected, tested and analyzed with regard to assess the various aspects of engineering properties. It is clear that for locally available sand and bricks, test results for different engineering properties vary with the sources location. The key findings are:

(i) The Fineness Modulus of sand collected from different sources falls below the standard limit, but the other properties including specific gravity, unit weight, salinity, chloride content of sand lies within standard limiting values.
(ii) Among all the sources Shilok sand is found satisfactory as it mostly complies with the standard limiting values.
(iii) The field test of first-class bricks collected from the various sources are found satisfactory. But for 2nd class and picket brick, the quality doesn't satisfy in maximum cases.
(iv) The unit weight, salinity and chloride content of bricks collected from different sources lies within the standard limit in most of the cases.
(v) Water absorption capacity of bricks lies within standard limit. However, 2nd class and picket bricks absorb more water and exceed the limiting value.
(vi) The crushing strength of bricks collected from all the sources falls below the standard limit.

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