

EFFECT OF SALINITY ON BRICK CLAY & ITS REDUCTION BY LEACHING PROCESS

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ABSTRACT

In the coastal region like Khulna zone, high concentration of salt is present in soil, water & bricks. This salinity leads to eventual damage to the masonry material. Also the effect of efflorescence is seen on the different parts of the building which is caused due to the presence of excessive salinity. This paper offers a review on the effect of salinity on brick clay & its reduction by leaching process. In this paper, experimental study was carried out to show the content of salinity on brick from various brick-fields like J.B.P, SUPER, UNITED, HIRA. The tests like Sulphate test, Chloride test, Compressive strength test, Efflorescence test, Absorption test were performed on the manufactured bricks as well as on the brick clay & water used in the manufacturing of bricks. The chloride content of various brick-fields was found in the range of 70-125 mg/L as SO₄²⁻ ion and sulphate content was in the limit of 398-646 mg/L. Leaching process was adopted for the reduction of salinity on brick clay of different brick-fields. A comparison of test results between original salinity condition of the bricks and the condition after leaching process has been shown. Moreover, the variations of salinity with different parameters have also been identified in this study. The experimental data reveals that, a significant amount of salinity is reduced on brick clay by using leaching process.

Keywords: Salinity; Leaching process; Masonry; Brick clay.

1. INTRODUCTION

Salinity is a great problem in coastal area like Khulna city. It affects public health, agriculture, and construction etc. of a coastal region. Generally building products are made with various materials such as sand, aggregates and water that may contain salts. Alternatively the finished product may be stored in a location which allows the addition of salts carried by wind, rain or from the ground to enter the finished product. Once the product is used in a building, sources of moisture, wind or rain can add more salts.

In engineering construction various proposal focusing on the choice of material depends upon several factors like availability of materials, economy, fabrication, strength, durability and workability. In the construction industry brick is one of the important building materials which are used as a ceramic material. Brick is an artificial kind of stone made of clay whose chief characteristics are a plasticity when wet and stone like hardness after being heated to high temperature. Brick is normally made from burning natural clay deposits (Aziz, 1995). Clay is a mixture of natural deposits formed by the weathering of certain rocks. Clayey soil is widely used as raw material in brick production. Practical applications prove that it can be widely used as a traditional building material due to its mechanical properties. Various types of soluble salts are known to cause damages to masonry structures. External masonry walls are greatly affected when they are exposed to these soluble salts. The mechanism of salt attack must be prevented and addressed thoroughly in order to maintain the integrity and service life of masonry wall (Habibur et al., 2010). Fultola, shiromony and daoulotpur Union are selected as study area to show the salinity effect on brick masonry structure. The specific objectives of this study are:

- To determine the salinity content of fresh brick stone & brick's soil of different brick field in Khulna region.
- To determine the absorption, efflorescence & compressive strength of fresh bricks.
- To minimize the salinity by leaching process.

- To recommend alternative ways in reducing salinity.

2. METHODOLOGY

2.1 Preliminary Field Survey

At first Preliminary field survey was done to find out the location of different brick field in fultola, douloapur, & shiromony region and also find out the affected brick masonry structures. At Jabdipur union and Teligati union most of the brick masonry structures are affected. Plasters of most of the buildings are seen scraped. At the study areas, a lot of buildings are adversely affected.

2.2 Detailed Field Investigation

For the field investigation it was found that in fultola region the J.B.P & SUPER brick fields using pond water for preparing the raw brick so that they contain small amount salinity. Otherwise UNITED brick had greater salinity value as it used river water. In shiromony and doulotpur region the different brick field like GOLD, SUN, KHAN, & BBC had shown high salinity as they were using tidal river water. The people of Teligati union and Jabdipur union in most cases use water from nearby water sources for construction purpose. Sometimes they use tube well water though there are some ponds near the houses. Maintenance work is rare in the buildings of Teligati Union. So that saline is affected in masonry building in these two regions.

2.3 Focus Group Discussion with Workers

A discussion work was done with workers of different brick field as how they prepare row brick and what water are used for preparing brick and then sample like soil, water, & fresh brick. Besides the discussion were made with people the Teligati and jabdipur union. Generally people of Teligati union are not concerned about salinity effect. Some people know the decay of brick and plaster is caused by salinity but they have no knowledge about reducing the problem. It is also seen that the south facing brick walls and walls at damp position like near drain are more affected than other sides.

2.4 Sample Collection and Taking Photograph

Here in Figure 1, photograph of the different bricks of different old buildings were taken to show the physical condition of the bricks on the building. Almost all the bricks have same condition. Efflorescence effect was strongly shown in all the bricks.



Figure 1: Photograph of different bricks from old buildings

2.5 Laboratory Test

Salinity test (as Cl^- ion and as SO_4^{2-} ion) was done for collected samples e.g. different bricks and soil & water in different brick field like J.B.P, SUPER, UNITED, SUN, KHAN, BBC & GOLD. Salinity test was performed at environmental engineering laboratory. Compressive strength test, efflorescence test, and absorption test of affected brick and new bricks from different brick fields were performed in Engineering Materials laboratory.

2.6 Arranging leaching filter & testing brick clay

The schematic diagram of the filtration unit is shown in Figure 2. For the purpose of reducing salinity leaching process was adopted. For the leaching process a cylindrical plastic container was used having 225mm diameter and 500mm height for predicting three companies clay leaching process. Potassium dichromate ($K_2Cr_2O_7$), silver nitrate ($AgNO_3$) and gypsum ($CaSO_4 \cdot 2H_2O$) were used to determine the amount of salinity and reducing the salinity of all clays sample respectively.

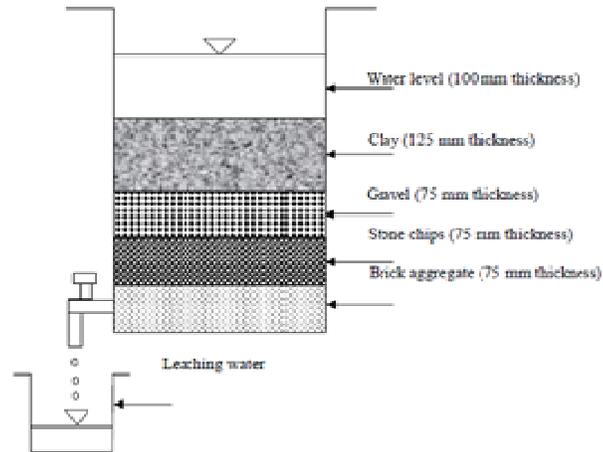


Figure 2: Typical arrangement of leaching process.

2.7 Operation and Maintenance

Soils of three different brick fields were collected and treated in this process. After treating these soils using leaching process, it brought to laboratory for the analysis. Generally salinity test was performed to find out if the saline content present in the soils was reduced or not.

3. RESULTS AND DISCUSSION

From the different brick field, seven samples from different brick field such as J.B.P, SUPER, UNITED, SUN, KHAN, BBC & GOLD were collected and tested. Seven types of brick, their manufacturing soil and water of study areas were collected. Salinity test of all those samples were performed. And their compressive strength test, absorption test, efflorescence test were performed.

3.1 Chloride (Cl^-) test for fresh bricks

From the test it is found that the Cl^- content on fresh bricks like J.B.P, SUPER, UNITED, SUN, KHAN, BBC and GOLD are 90 mg/l, 70 mg/l, 118 mg/l, 125 mg/l, 116 mg/l, 93 mg/l and 85 mg/l. Average value of chloride is 80 mg/l. So, we can see that SUN brick has highest chloride content than others, which means Sun brick shows more salinity than other bricks. And J.B.P has average chloride content.

3.2 Sulphate (SO_4^{2-}) test for fresh bricks

From the test it is found that the SO_4^{2-} content on fresh bricks like J.B.P, SUPER, UNITED, SUN, KHAN, BBC and GOLD are 540 mg/l, 470 mg/l, 500 mg/l, 646 mg/l, 585 mg/l, 568 mg/l and 398 mg/l. Average value of sulphate is 475-525 mg/l. So, we can see that SUN and KHAN bricks have highest SO_4^{2-} content than others, which means SUN and KHAN bricks show more salinity than other bricks. And UNITED and SUPER have average SO_4^{2-} content.

3.3 Absorption test for fresh bricks

From the laboratory test we it is found that the water absorption on fresh bricks like J.B.P, SUPER, UNITED, SUN, KHAN, BBC and GOLD are 25.86%, 29.68%, 23.75%, 31.92%, 28.65%, 27.51% and 21.92%. Average value of water absorption is 27.0%. So, we can see that SUN brick has highest water content than others. So it can be said that it has more pores which means it is more susceptible to contain more salt. And B.B.C and KHAN have average water content.

3.4 Compressive Strength test for fresh bricks

From the test it is found that the compressive strength on fresh bricks like J.B.P, SUPER, UNITED, SUN, KHAN, BBC and GOLD are 3365 psi, 3580 psi, 2550 psi, 1940 psi, 2240 psi, 2150 psi and 2362 psi. Average value of compressive strength is 2660 psi. So, we can see that J.B.P and SUPER bricks have highest compressive strength than others, which results that the pores present in those bricks is less than other bricks. So these bricks have less saline effect than other bricks. And UNITED has average compressive strength.

3.5 Efflorescence test for fresh bricks

From the analysis it is found that the collected brick samples have efflorescence potential almost nil. Due to repeated wetting and drying of structure, efflorescence is formed after a long time. The brick samples were immersed in water for 24 hours and then dried in shade for seven days. After seven days it was observed that UNITED has not more than 10 percent of any surface of specimen covered by a thin deposit of salt. And other bricks have almost nil efflorescence.

3.6 Chloride (Cl⁻) test for brick clay

From the test it is found that the Cl⁻ content on brick's soil from brick fields like J.B.P, SUPER, UNITED, SUN, KHAN, BBC and GOLD are 80 mg/l, 310 mg/l, 210 mg/l, 470 mg/l, 330 mg/l, 280 mg/l and 305 mg/l. Average value of chloride is 283 mg/l. So, we can see that KHAN, BBC and SUN bricks clay have highest chloride content than others, which means these brick clay show more salinity than others. And GOLD has average chloride content.

3.7 Sulphate (SO₄²⁻) test for brick clay

From the test it is found that the SO₄²⁻ content on brick clay from brick fields like J.B.P, SUPER, UNITED, SUN, KHAN, BBC and GOLD are 37 mg/l, 104 mg/l, 132 mg/l, 89 mg/l, 109 mg/l, 87 mg/l and 57 mg/l. Average value of sulphate is 88 mg/l. So, we can see that UNITED, SUN and KHAN brick soil have highest SO₄²⁻ content than others, which means these brick clay contain more salinity than other bricks. And BBC has average SO₄²⁻ content.

3.8 Effect of salinity after leaching process

The soil used for manufacturing UNITED, SUN and KHAN bricks are taken for leaching process. In the filter: brick clay, gravel, stone chips and brick aggregates are placed immediately one another. After that water is allowed to flow around 10 days. After 10 days of filtration, remaining brick clay on the filter is tested. It is found that Chloride content of UNITED; SUN and KHAN brick clay are reduced about 48.09%, 58.94% and 60.3%. Again sulphate content of UNITED, SUN and KHAN brick clay are reduced about 41.67%, 40.45% and 36.69%. Content of Chloride and sulphate, before and after leaching process are shown in Table 2.

Table 1 summarizes test results of the Chloride content, Sulphate content, Absorption, Compressive strength of fresh bricks and Chloride content as well as Sulphate content of brick clay. Table 2 summarizes the comparison of salinity (SO₄²⁻ content & Cl⁻ content) in normal clay & leaching clay.

Table 1: Parameter tested for fresh bricks

Frog Mark	Cl ⁻ content on fresh bricks (mg/l)	SO ₄ ²⁻ content on fresh bricks (mg/l)	Absorption (%)	Compressive strength (psi)	Cl ⁻ content on brick clay (mg/l)	SO ₄ ²⁻ content on brick clay (mg/l)
J.B.P	90	540	25.86	3365	80	37
SUPER	70	470	29.68	3580	310	104
UNITED	118	500	23.75	2550	210	132
SUN	125	646	31.92	1940	470	89
KHAN	116	585	28.65	2240	330	109
BBC	93	568	27.51	2150	280	87
GOLD	85	398	21.92	2362	305	57

Table 2: Comparison of salinity (SO₄²⁻ content & Cl⁻ content) in normal clay & leaching clay

Frog mark	Before leaching		After leaching	
	Cl ⁻ (mg/l)	SO ₄ ²⁻ (mg/l)	Cl ⁻ (mg/l)	SO ₄ ²⁻ (mg/l)
UNITED	210	132	101	55
SUN	470	89	277	36
KHAN	330	109	199	40

Graphical representation of various parameters of brick like Cl⁻ content on fresh bricks (mg/l), SO₄²⁻ content on fresh bricks (mg/l), Absorption (%), Compressive strength (psi) are shown in Figure 3. In Figure 4, Graphical representations of reduction of salinity (Cl⁻ & SO₄²⁻) for UNITED, SUN and KHAN bricks clay are shown.

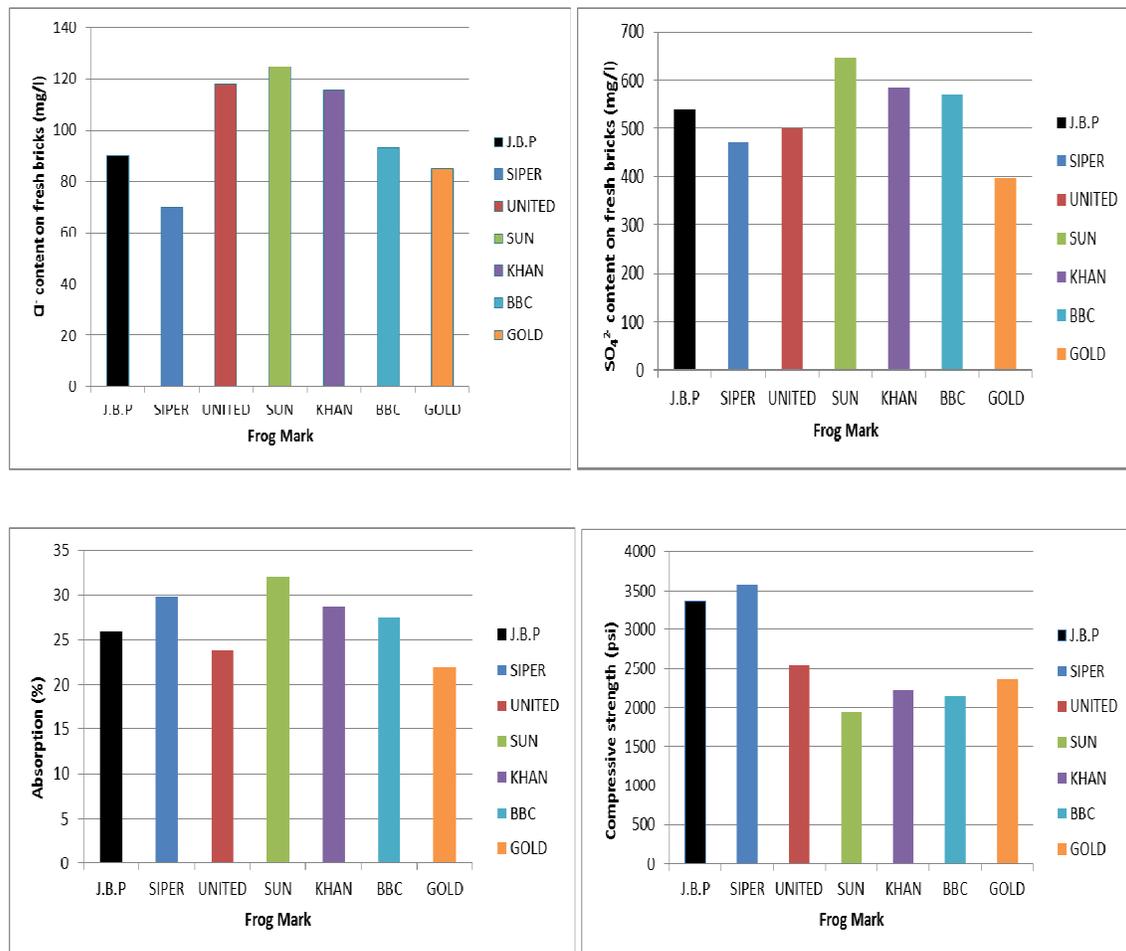


Figure 3: Graphical representation of various parameters of fresh brick

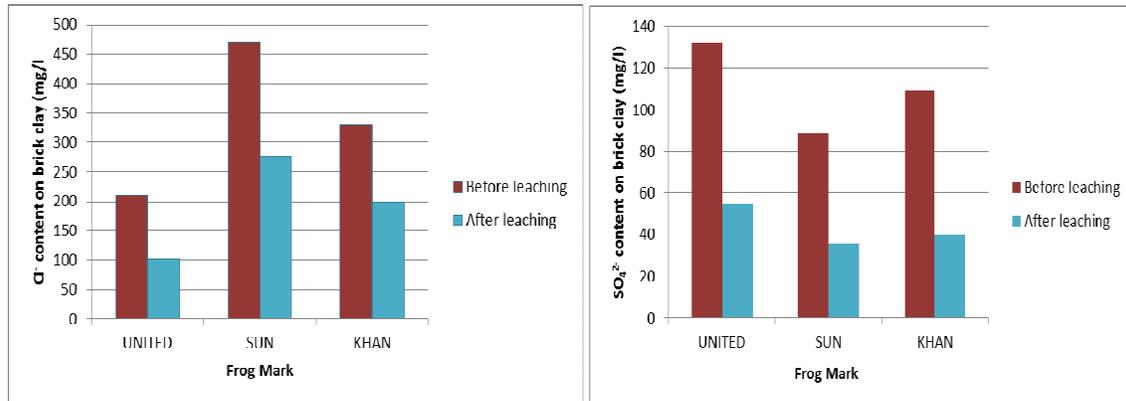


Figure 4: Graphical representations of reduction of salinity on brick clay

4. CONCLUSIONS

Salinity is one of the striking problems in southern part like Khulna division in Bangladesh. Salt intrusion from different potentially hazardous saline solution causes distressed bricks. And it has adverse effects on structure. Efflorescence effect is more dangerous among all the adverse effects. From the field observation it has been found that the brick from various brickfields contain excess amount of saline. From laboratory tests it has been found that salinity effect increases with time. From the laboratory tests it can be said that saline content in SUN, KHAN, UNITED bricks is more than the other brick, because generally tubewell water is used in these brick fields for manufacturing bricks. It is also found that the brick in fultola region like J.B.P, SUPER has less saline effect than other bricks, since in Fultola region, generally river water is used for manufacturing the bricks. By leaching process about 48.09%, 58.94% and 60.3%. Cl⁻ content and 41.67%, 40.45% and 36.69% of SO₄²⁻ content for UNITED, SUN, KHAN bricks clay are reduced.

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