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CHARACTERIZATION OF BRICK MASONRY OF OLD AND NEW BUILDING BLOCKS AT GCT RASUL

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Abstract- In historical buildings the clay brick masonry was used in too much quantity. In order to characterization of brick masonry of old and new building block at GCT Rasul, for this purpose 12 samples of clay brick specimen, cement and lime mortar were collected from main (old) building block and B-Tech new building block. All the collected samples were characterized and evaluated physically, chemically and mechanically. After study and evaluation, the large variation in the properties was found. Furthermore, the sample of lime mortar which was used for the construction of main building block and the sample of cement mortar which was used for the construction of new B-Tech building block were also analyzed. The result of main (old) building and new B-Tech building were compared. And a significant difference was found in chemical properties, mechanical properties, water absorption, porosity, of old bricks was high which was constructed by using lime mortar and the water absorption and porosity of new building bricks was low which was constructed by using cement mortar. The main building block and new B-Tech building block were constructed 1912-16 and 1980-86 respectively.

Keywords- clay bricks, XRD of brick, physical and mechanical test of brick, chemical composition of mortar

1 INTRODUCTION

The Government College of Technology Rasul is housed in a spacious, well maintained two hundred- and fifteen-acres area. It is located about 40 km away from G.T road approachable from Kharian and Sara-e-Alamgir whereas 14 km from District Headquarter Mandi Bahauddin through road.

1.1 Material and Method

The brick, cement mortar and lime mortar used in this work was raw material collected from two different sources namely Main building block and B-Tech building block situated in GCT Rasul. The lime mortar is to be used for the construction of Main building block and cement mortar is to be used for construction of B-Tech building block. Brick sample were collected namely MB1, MB2, MB3, MB4, MB5 and MB6 from Main Building block and BT1, BT2, BT3, BT4, BT5, and BT6 from B-Tech building block respectively.

Ingredients of good brick earth

Silica	50-60%
Alumina	20-30%
Lime	10%
Magnesia	< 1%
Ferric oxide	< 7 %
Alkalis	< 10%
Carbon dioxide	Very small %
Sulphur trioxide	Very small %
Waters	Very small %

Figure 1:Ingredients of good brick earth

In this study an effort will be made to find the better combination, when damaged historical masonry needs to be restored with substitution bricks, a good characterization of both new and old material lets us forecast the chemical behaviour of the system.

2 RESULTS AND DISCUSSION

2.1 Chemical Composition of Cement and Lime Mortar

Chemical compositions of cement and lime mortar samples are presented in Table 1.1. It was observed that the silica content approximately 12.7 % higher in cement mortar and a miner difference of Calcium Oxide (CaO) in between cement and lime mortar.

Table 1: Chemical composition of cement and lime mortar

S/No	Element	% Cement mortar used in B-Tech Department Block	% Lime mortar used in Main Building Block
1	Calcium Oxide (CaO)	11.76 %	10.36 %
2	Silica (SiO2)	73.20 %	60.50 %
3	Magnesium Oxide (MgO)	01.60 %	02.40 %
4	Alumina (Al2O3)	03.10 %	06.20 %
5	Iron Oxide (Fe2O3)	01.10 %	02.41 %
6	Losses on Ignition (L.O.I)	07.60 %	09.90 %
7	Sulfur Trioxide (SO3)	01.72 %	02.65 %
8	Ratio	Cement: Sand; 1: 4.17	Lime: Sand 1: 4.87

2.2 X-Ray Diffraction (Xrd) Analysis of Bricks

X-ray diffraction XRD was performed on all 12 brick samples (6 collect from Main (old) Building block & 6 from B-Tech (new) building block) throughout this thesis. The most prevalent mineral found throughout the study was quartz. This was seen not only in the brick samples. From the compositional consistencies seen throughout the 12 brick samples, it was ascertained that the bricks from Old & New building block were all locally manufactured. Bricks were observed to be compositionally similar. Though different in intensities, the presence of quartz was consistent in both samples. Typically, it was observed that the darker bricks contained hematite, which has been seen experimentally in bricks that are fired at hotter temperatures, usually above 900^{o} C.

X-ray diffraction pattern of Main building block (100 years old) brick and B-Tech building block brick are presented in Fig 2. Peak 2θ degree positions for the main building block brick sample [Fig 1] at 26.82, 36.88, 50.22, 60.44 and 68.30 with the maximum relative intensity and those for B-Tech building block brick sample [Fig 1.2] at 20.76, 26.66, 34.60, 50.06 and 68.16, with the maximum relative intensity; clearly show the presence of quartz in the samples. Quartz (SiO_2) is a common constituent of granite, sandstone and limestone. Sharpness of peaks in the XRD spectra also indicates that SiO_2 could be in the crystalline form. XRD- spectrum of sample indicated that the main composition of sample was a-quartz.

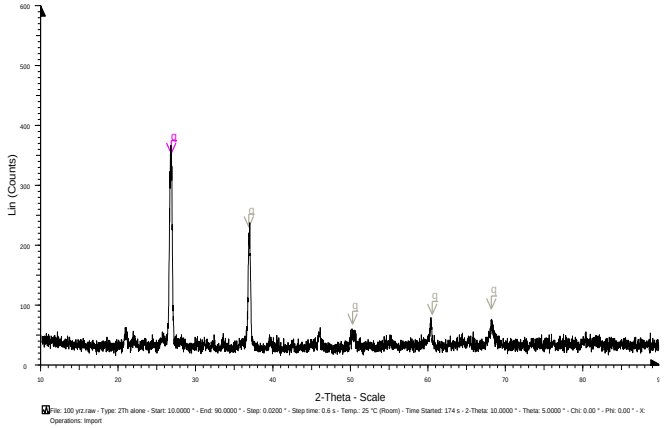

Figure 2: XRD Pattern for 100-year-old brick of Main building block

3. DESCRIPTION OF THE ORIGIN AND MEASUREMENT THE SIZES OF BRICKS

ASTM C-67-03a is used to determine the sizes of bricks samples collected from the main and B-Tech building block. The measurement sizes test results are summarized in table 1.2. It is noticeable that the length and width of 100 years old bricks collected from Main building block is 18 % and 12 % greater as compared to the B-tech building block brick respectively. The thickness of bricks used in these building blocks is almost same.

Table 2: Comparison of sizes of Main and B-Tech building blocks

Monument	Construction period	Location	Dimension (mm)	Specimen Name
GCT Rasul	1912-16	Main Building Block	260x128x70	MB1
			260x126x70	MB2
			246x120x70	MB3
			260x128x70	MB4
			259x127x69	MB5
			246x121x70	MB6
	1980-85	B-Tech Building Block	220x115x70	BT1
			221x115x69	BT2
			220x114x70	BT3

3.1 Compressive Strength and Bulk Mass of Brick Specimens

ASTM C-67-03a is used to determine the compressive strength and bulk mass of brick samples, collected from main and B-tech building block at GCT Rasul. The Table 1.4 and Fig 1.3 shows the compressive strength (fc') and bulk mass result of 100 years old (Main building block) and new building block (B-Tech building) brick samples.

Generally, a large variability on the compressive strength was obtained on B-Tech building block brick samples with highest 20.399 MPa on BT2 sample brick and lowest value 13.640 MPa on sample BT6 brick sample. Similarly, a small variability on the compressive strength as well as bulk mass were obtained on 100 years old brick samples (Main building block) with a highest value 23.712 MPa on sample No MB3 brick and lowest value 19.399 MPa on sample No MB5 brick.

Table 4 and Figure 3 clearly shows that the compressive strength of Old building block (Main building block) brick samples is 39 % greater to the new building block (B-Tech building block) brick samples.

S/No	Area	Load	Compressive strength fc'	Bulk mass
	mm2	N	(MPa)	Kg/m3
MAIN BUILDING BLOCK				
MB1	33280	648065	19.473	1707.589
MB2	32760	707886	21.608	1687.162
MB3	29520	700000	23.712	1761.033
MB4	33280	658035	19.772	1707.160
MB5	32893	638095	19.399	1718.351
MB6	29766	687946	23.111	1751.758
Average			**21.180**	**1722.175**
B. TECH BUILDING BLOCK				
BT1	25300	368898	14.580	1405.985
BT2	25415	518452	20.399	1417.056
BT3	25080	348958	13.913	1434.267
BT4	25300	358928	14.186	1402.597
BT5	25530	378868	14.840	1407.835
BT6	24852	338988	13.640	1419.833
Average			**15.260**	**1414.595**

4 CONCLUSIONS

Based on the experimental study on the brick's samples, cement and lime mortar following conclusions can be drawn

- The XRD study conclusively establishes the presence of quartz in the brick samples.
- The sizes of bricks especially length and width used for the construction of Main building block are greater than bricks used in B-tech building block approximately 40 mm and 14 mm respectively. Therefore, new bricks could not be used for replacement of old bricks in the damaged portion of 100 years old Main building block masonry.
- The lime mortar with ratio (1:4.87) and cement mortar with ratio (1:4.17) are to be used for the construction of Main and B-tech building block masonry respectively.
- The compressive strength and bulk mass of brick used for the construction of Main building block is approximately 39 % and 22 % respectively greater than brick used for the construction of B-Tech building block. Therefore, old brick is most durable as compare to new building block brick.

So, it is concluded for characterization of brick masonry of old and new building blocks at GCT Rasul, that the width of wall is so greater because the length of old brick is greater therefore, at this stage masonry of old building block is durable and well condition.

Figure 3: a) Photo of Main building block (Old block); b) Photo of B-Tech building block (New block)

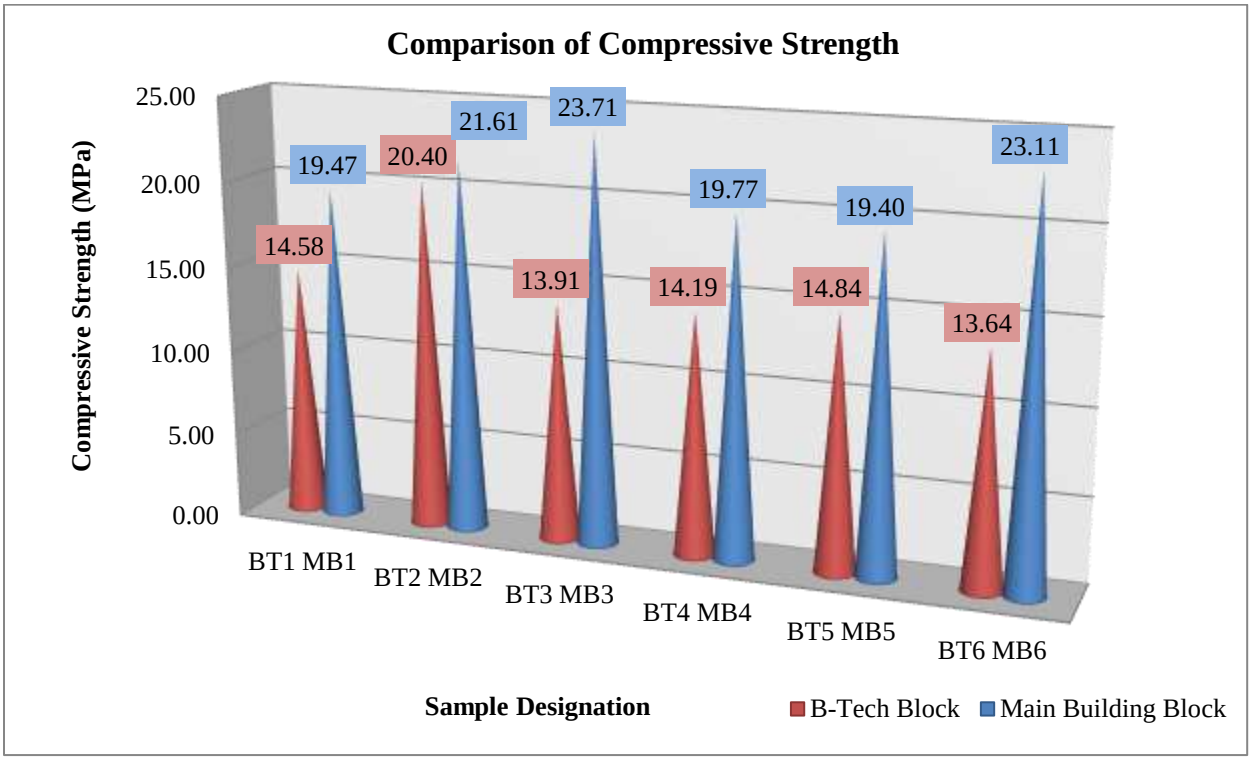

Figure 4: Graph showing the Compressive Strength of Brick

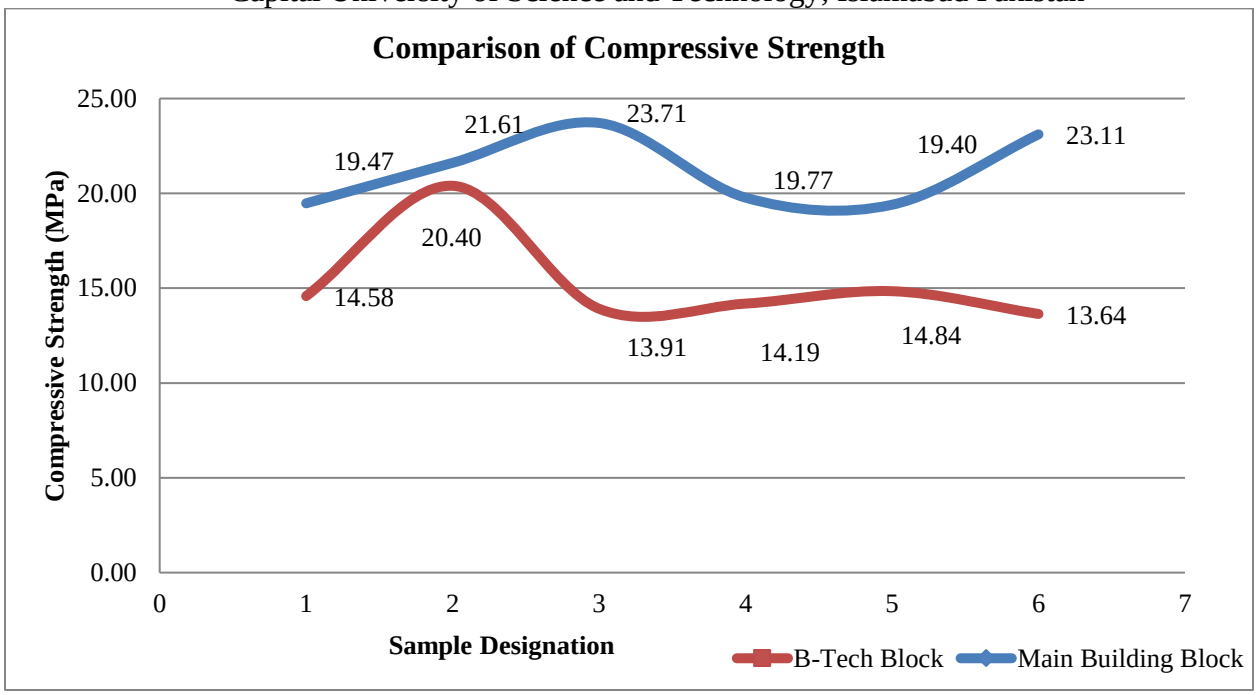

Figure 5: Graph showing the Compressive Strength of Brick

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