Experimental Approach to Investigate the Behavior of Locally Available Bricks

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Abstract— The brick is an integral part in the field of construction. It has its own importance in the construction industry. So the study of brick in construction which are locally available is very important. There are many standards defining the physical properties of brick as IS code. The study plays a vital role in comparing the properties of the locally made bricks with the standards, weather they meet the minimum requirement or not. Various tests are carried on the brick units such as compression test, water absorption test, flexural strength test for defining there quality. The results obtained are useful in analyzing the strength of brick masonry under compression loading.

I. INTRODUCTION

A brick is block or a single unit consisting of earth, sand and lime, or concert materials used in construction process. Bricks are manufactured in various classes depending upon type of materials and sizes which may vary with region and time period. These are produced in bulk numbers.

In the history of construction, brick masonry has its own footprint. Many major historical structures are of brick masonry structures. From then brick masonry has gained its popularity because of its ease in manufacturing process. Since then, this most economical and suitable method of construction gained more importance and huge structures started to emerge all over the world. The materials required for construction of brick masonry were easily available in the olden days.

As time passes, new technologies brought in the field of construction. Using of new technologies helped in increasing the strength and durability of the structures. However, this requires huge investments in this affected the economical construction. New research and development were start in the field of construction in developed countries which overtook the importance of brick masonry

Still now, masonry structures are in practice in numerous cities all around the world because it could only satisfy the basic requirements of the people. But due to improper design, lack of practical results many ancient structures were failed which will not hold the strength and durability factors. This necessitated further research and investigation in the field of brick construction. Many researches were carried out on the brick units and constituent materials

The present paper deals with the experimental investigations of the constituent material properties of the brick masonry. Burnt clay bricks of standard size are used to determine their individual properties. The flexural strength of unit brick is found using flexural testing based on the Indian standard code.

II. LITERATURE

As a result of the literature study, few important observations are listed as follows.

Nowfer carried out uniaxial compressive test to determine the mechanical properties of unreinforced masonry constituent materials. Based on the results, the stress-strain relationship is defined and a simple numerical model is also formulated to estimate the elastic modulus. The values are used as the input for the numerical modeling of masonry which is used for nonlinear finite element analysis.

Sarangapani et al [2002] compared the characterization and properties of local low modulus bricks, table moulded bricks and wire cut bricks, mortars and masonry. Leaner mortars such as 1:6:9 cement – soil mortar showed very ductile behavior which was indicated as the stress-strain curve becoming horizontal after reaching a peak strain value.

Deodhar and Patel [1997] presented that under compression; mortar deformed more than brick and expanded laterally causing failure of masonry. With the strength of brick and mortar, the compressive strength of brick

masonry was evaluated with the constants given. It was found that rich mortar does not improved the strength of masonry but for low strength bricks a mortar ratio 1:4 or 1:5 gave considerably high strength.

Aravind Galagali [2004] reported that the current IS code provided the use of rich mortar (CM 1:6) in the masonry. But such a rich mortar was not essential in the brick masonry. Hence suitable modifications were made and a provision of use of 'masonry mortar' which was produced replacing cement by fly ash up to 30% was studied. This obliviously led to saving in the cost of the construction project.

III. PROPERTIES OF MATERIALS

Brick masonry is not a homogeneous material it exhibits heterogeneous property due to different constituent materials. Hence, it is necessary to study the various properties of material used in brick masonry work to understand the behavior of masonry using different testing machines. Individual properties of bricks were carried out.

A. Brick

Brick used for research work are of clay brick, hand made, ground moulded, clamp burn. The dimension of the brick is measured using verneriner scale to least of 0.01mm. the average dimensions was found to be 220mm×100mm×75mm. the quality of brick is ensured by its appearance and the good bricks are selected from the brick stack as per requirements.

B. Cement

The 43 OPC is used for filling the frogs of the bricks. The cement mortar is prepared using this OPC and fine aggregates passing through 4.75mm is sieve with a water cement ratio of 1.

C. Sand

The natural sand is used to prepare the cement mortar as pr the mix design. The sand used is sieved through is sieve 4.75mm.

IV. TESTS ON BRICK UNITS

Tests on individual brick include the compressive strength of brick, water absorption test and flexural strength of brick units using relevant codes.

1. WATER ABSORPTION TEST.

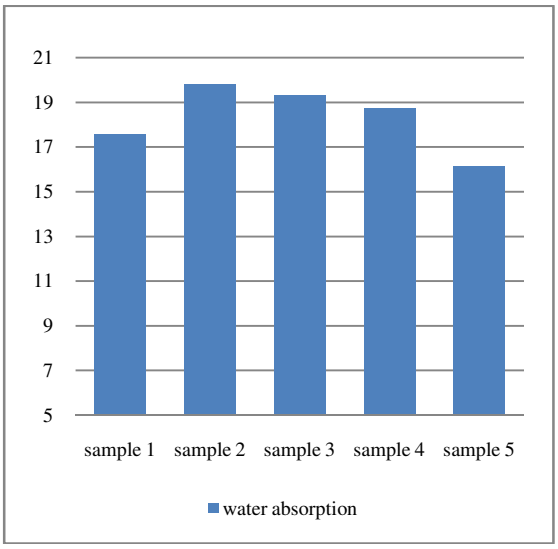
The dry weight of individual bricks is taken using weighing balance reading nearest to 0.01% of the mass of the specimen. Total three numbers of bricks from each of the sample is taken and immersed in clear water for 24 hours at a temperature of about 27c±2c. After this period again bricks are weighed. Using fallowing formula, water absorption of bricks in percentage is calculated.

$$\frac{M_2 - M_1}{M_1} \times 100 \qquad (1)$$

The water absorption values of bricks used in the present study are tabulated as below

Table I Water Absorption Test on Brick

Sample. No	Specimen. No	Dry Weight	Wet Weight	% Of Water Absorption	Avg.Water absorption
1	1	3.095	3.645	17.771	17.567
	2	3.145	3.670	16.693	
	3	3.180	3.760	18.239	
2	1	2.580	3.100	20.155	19.824
	2	2.770	3.300	19.134	
	3	2.750	3.305	20.182	
3	1	2.565	3.060	19.298	19.299
	2	2.540	3.100	22.047	
	3	2.870	3.345	16.551	
4	1	2.885	3.370	16.811	18.741
	2	2.750	3.290	19.636	
	3	2.680	3.210	19.776	
5	1	2.845	3.310	16.344	16.106
	2	2.955	3.425	15.905	
	3	2.925	3.395	16.068	



2. COMPRESSION TEST ON BRICK.

The maximum load that the burnt clay brick can withstand is determined using the compressive strength test as per IS 3495 (Part 1): 1992. Compressive strength of brick depends upon the composition of clay, method of brick manufacturing and degree of firing. The bricks are tested along X-axis both in wet and dry conditions as shown in Fig 1.

1. APPARATUS

A compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which coincides with the centre of the plate, shall be used.

2. PRECONDITIONING

Remove unevenness observed in the bed faces to provide two smooth and parallel faces by grinding. Immerse in water at room temperature for 21 hours. Remove the specimen and drain out any surplus moisture at room temperature. Fill the frog (where provided) and all voids in the bed face flush with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). Store under the damp jute bags for 24 hours followed by immersion in clean water for 3 days. Remove, and wipe out any traces of moisture.

3. PROCEDURE

Place the specimen with flat faces horizontal, and mortar filled face facing upwards between two 3-ply plywood sheets each of 3 mm thickness and carefully centered between plates of the testing machine. Apply load axially at a uniform rate of 14 N/mm* (140 kgf/cm^2) per minute till failure occurs and note the maximum load at failure. The load at failure shall be the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Compressive Strength = $\frac{maximum\ load\ at\ failure}{contact\ area}$ in N/mm^2 ---------- (2)

The load at which the brick fails in (N) is noted and the maximum compressive strength of individual brick is evaluated by the above mentioned equation (2) and the values are given in Table II and Table III.

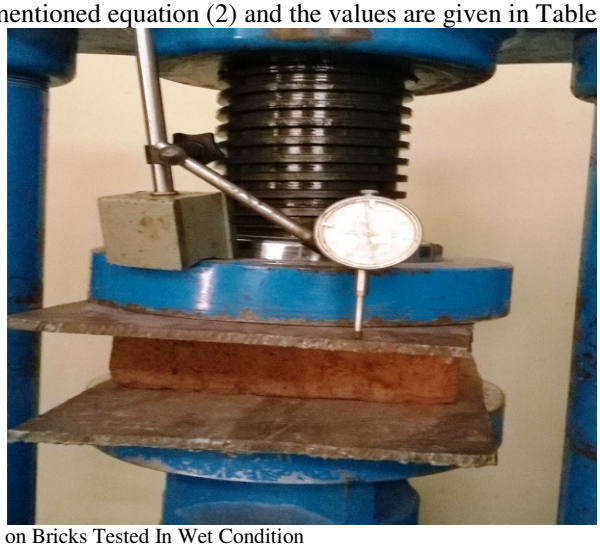


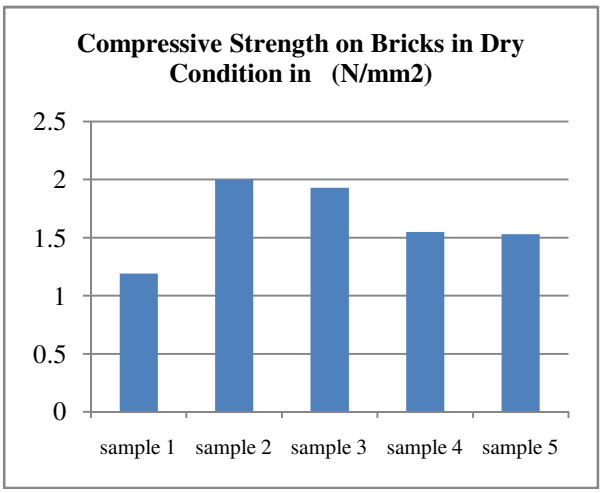
Table II Compressive Strength on Bricks Tested In Wet Condition

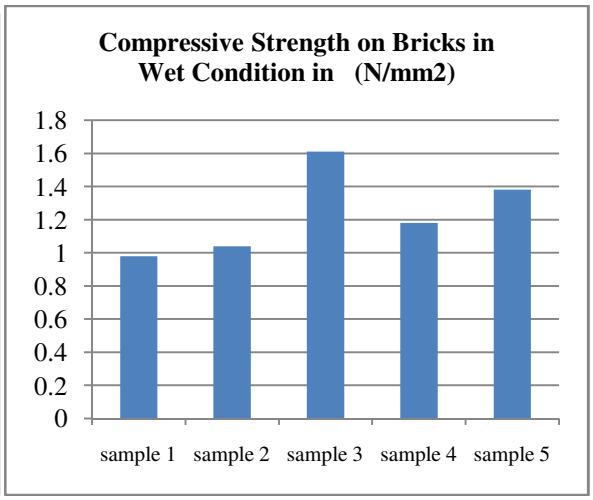
Specimen.	Sample. No	Area (mm^2)	Load (N)	compressive strength (N mm^2)	Avg.compressive strength (N/mm^2)

No					
1	1	22200	25000	1.13	
	2	21756	20000	0.92	0.98
	3	22420	20000	0.89	
2	1	22440	25000	1.11	
	2	22145	25000	1.13	1.04
	3	22969	20000	0.87	
3	1	22321	35000	1.57	
	2	23192	40000	1.72	1.61
	3	22560	35000	1.55	
4	1	23400	25000	1.07	
	2	22848	25000	1.09	1.18
	3	22542	30000	1.33	
5	1	21658	30000	1.39	
	2	21462	30000	1.40	1.38
	3	22220	30000	1.35	

TABLE III Compressive Strength on Bricks in Dry Condition

Specimen .No	Sample. No	Area (mm^2)	Load (N)	compressive strength (N/mm^2)	Avg.compressive Strength (N/mm^2)
1	1	22121	25000	1.13	
	2	22646	30000	1.32	1.19
	3	22420	25000	1.12	
2	1	22119	45000	2.03	
	2	21700	45000	2.07	2
	3	23400	45000	1.9 2	
3	1	22763	45000	1.98	
	2	22746	45000	1.98	1.93
	3	21952	40000	1.82	
4	1	22746	35000	1.54	
	2	22848	35000	1.53	1.55
	3	22018	35000	1.59	
5	1	21658	30000	1.39	
	2	21560	35000	1.62	1.53
	3	22220	35000	1.58	





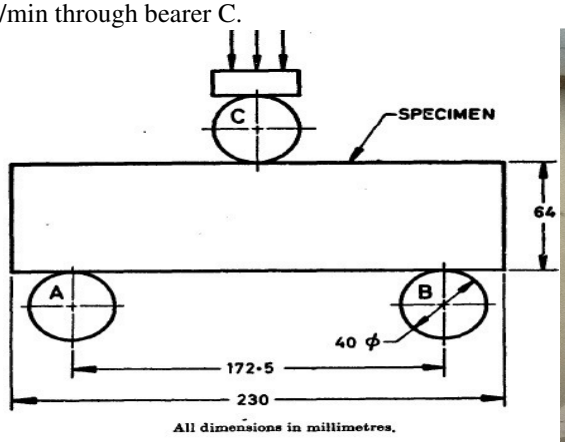
3. FLEXURAL STRENGTH TEST ON BRICKS

1. PREPARATION OF TEST SPECIMEN

The test specimens shall be whole bricks the dimensions of which shall be measured to the nearest 1 mm. A minimum of five bricks shall be separately tested. The test specimens shall be immersed in water at 27 f 2°C for 24 hours.

2. PROCEDURE

The test specimen shall be placed centrally *on* self-aligning bearers *A, B* and C as shown in Fig. The bearers shall be of mild steel 40 mm in diameter and shall be in the same horizontal plane and parallel to each other. The distance between the bearers *A* and *B* at the lines of contact with the specimen shall be three-fourths of the length dimension of the brick. Bearer C shall be midway between bearers *A* and *B* measured horizontally and rests upon the surface of the specimen. The load shall be applied at a uniform rate not greater than *30* kg/min through bearer C.



3. CALCULATION

The individual breaking load shall be recorded and the flexural strength calculated by the following formula:

$F = \frac{3PL}{2BD^2}$

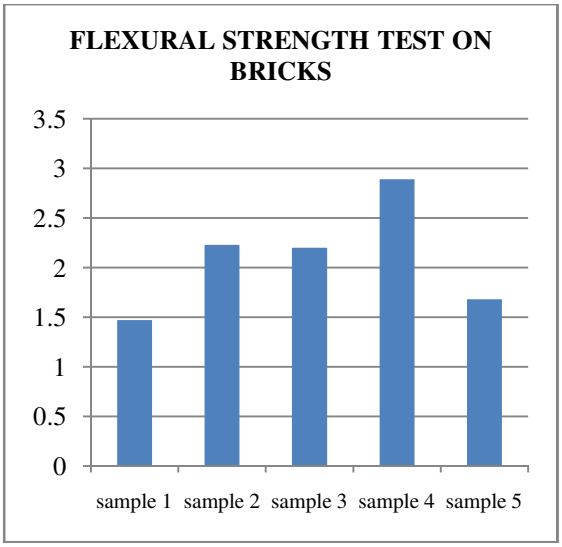
F = flexural strength of the brick in kg/cm^2,
P = load in kg,
L = span in cm,
B = width of the brick in cm, and
D = depth of the brick in cm.

Following Are The Results Of Flexural Strength On Bricks.

TABLE IV FLEXURAL STRENGTH TEST ON BRICKS

Sample No	Specimen No	Failure Load	Flexural Strength	Avg.Flexural strength
1	1	2145	1.44	
	2	2250	1.52	1.47
	3	2174	1.46	
2	1	3261	2.20	
	2	3410	2.30	2.23
	3	3216	2.17	
3	1	3700	2.25	
	2	3552	2.16	2.20
	3	3626	2.21	
4	1	4440	2.77	
	2	4810	3.00	2.89
	3	4662	2.91	

5	1	2516	1.56	
	2	2960	1.83	1.68
	3	2670	1.65	



RESULTS AND CONCLUSION

The test was carried out in the city of Vijayapura in the state of Karnataka, India. Locally manufactured, handmade, ground moulded, clamp burned bricks are collected from the various manufactures in the vicinity of Vijayapura.

From the laboratory results we came know that the average compressive strength of bricks is found to be 1.24 N/mm^2 while tested in wet condition and found 1.64 N/mm^2 while tested in dry condition, the average flexural strength of bricks found to be 3.50 N/mm^2 and average water absorption is 18.30% *(As compared to Is 1077:1992 specification for common clay building bricks minimum class designation for brick is 3.5 who's minimum compressive strength should not be less than 3.5 N/mm^2).*

Even though the bricks are manufactured in the same vicinity their physical for different for different manufactures. As per our observation we came to know that the bricks which are light brown in color will take very less load and the bricks which red and dark red in color will express more strength. This may be due change in quality of soil which used in manufacturing and the method and duration of burning usually these bricks are burnt in clamp. These bricks are hand moulded, and comes in class-III IS classification.

FURTHER SCOPE

The test was conducted in very small vicinity, as further study the test can be extended to national level in which samples are collected from various parts of the country and tested and evaluated, weather they meet standards or not. Because it is not possible to meet the standards every time, standard are standardized according to laboratory conditions, but practical situations differ from laboratory conditions, there are so many factors reducing the practical values. Once we identify them, then we can achieve 100% efficiency in all works.

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