IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Comparative Analysis Of The Structural Behavior And Properties Of Burnt Clay Bricks And Fly Ash Bricks

AUTHORS

Mohd Javed*[1] and Mahendra Kumar Singar[2]

[1*]MTech. Scholar, Department of Civil Engineering, Vivekananda Global University, Jaipur, Rajasthan

[2]Supervisor, Department of Civil Engineering, Vivekananda Global University, Jaipur, Rajasthan

ABSTRACT

Structural behaviour of masonry unit is influenced by constituents units like bricks and mortar individually and as composite mass together. As bricks are made with locally available clay with different mineral composition properties of bricks vary widely from zone to zone. Thus average value of constituting material behaviour may over estimate or under estimate the design and analysis of masonry structure. For safer and economical design of masonry structure the variability of constituting material properties is necessary to be considered. So the mathematical description of the randomness of constituting material is required, the variability of mechanical properties related to steel and concrete is well researched, while the same for brick masonry has not received proper attention.

In plane strength is an important aspect in sustaining with In plane forces for achieving better in plane strength soaking is very important, as bricks absorbs moisture from the mortar which leads to in habiting hydration of cement. In this study, for mechanical behaviour a number of experiments are conceded for determining initial moisture absorption rate, moisture absorption, apparent dry density, crushing strength of units, crushing strength of mortar and of the composite unit

Keywords: Burnt Clay Bricks, Fly Ash Bricks, BCB, BFA-1, BFA-2.

1. Introduction:

"Every creature in this universe need a habitat where they lives and evolve likewise for human being that habitat is their house where they lives and spend their life. A habitat must be comfortable and safe against natural agencies. In past centuries before industrial era houses are constructed using wood, grass and clay but these recourses are not permanent, thus for a permanent house human evolve bricks which are just a burnt clay cuboids Which joined together by clay to make a parament house. After industrial era cement gets invented by English's and burnt bricks are joined to gather by cement, which is now a days called as masonry, as bricks are the main intergradient in the masonry it is termed as brick masonry. Among different types of masonries, brick masonry in India is one of the most widely used and thereby because of its low cost, the easy availability of raw materials, good strength, easy construction with less supervision, possesses good sound and heat insulation properties, and easily availability of man power.".

In our country, approximately 143 thermal power stations consume about 500 million tons of coal annually, resulting in the production of around 173 million tons of fly ash. To address this issue, the government and experts emphasize the safe disposal and reuse of fly ash, particularly in brick production.

Using fly ash in brick manufacturing for multi-story buildings has gained popularity in various construction fields. Until 2014, about 13% of the total fly ash produced was utilized in bricks, and this trend is expected to increase further. This shift from clay bricks to fly ash-based bricks helps preserve land from erosion, reduces greenhouse gas emissions since excess fossil fuels are no longer used for burning clay bricks, and offers structural advantages like lower cost, higher compressive strength, accurate shape and size, high strength-to-weight ratio, zero efflorescence, and reduced mortar consumption, resulting in cost-effective construction. The properties of fly ash depend on factors such as the type and quality of coal used and the burning process. It primarily consists of silicon dioxide, aluminium oxide, calcium oxide, and various heavy metals. According to ASTM C-618, fly ash is broadly classified into two types: Class F and Class C. The physical and chemical requirements for fly ash are specified in the Indian Standard IS:3812-1981.

The overall production of fly ash stands at 173 million tons out of this only 99.30 million tons is utilized. That means only 57.63% of fly ash generated is used for various purposes. This is proves that still nearly 33% is left unused every year. Realizing this, the government has passed resolution to make the use of fly ash compulsory for all construction purposes in around 100km radius of coal based plants. Fly as him majority can be utilized in making bricks, as bricks are the integral part of every type of construction. The use of fly ash in bricks has gained momentum after its properties being proven superior to fired clay bricks

2. MATERIALS AND METHODS:

This study is based upon series of test to be carried out to find the behaviour of composite brick unit. Initial rate of moisture absorption, moisture absorption, Density and Crushing strength are the key field of this study to describe about the behaviour of masonry unit. For preparing the test sample burnt clay bricks and fly ash bricks, PPC cement and local sand is used. Formation of masonry units are arranged in the pattern of three brick units and single brick unit. PPC cement and local cement is utilized for mortar

3. RESULT AND DISSCUSSION:

3.1. IRMA VARIATION

The IRMA for the BCB varies from 3.56- 3.78 Kg/m2 /min with a Co efficient of variation of 0.07, that for the BFA-1 it varies from 4.12- 4.89 Kg/m2 /min with a Co efficient of variation of 0.05 and for BFA-2 IRMA varies from 2.12-2.85 Kg/m2 /min with a Co efficient of variation of 0.09. However, From the mean values it can be seen that the mean values for the BCB, BFA-1 and BFA-2 are 3.55, 4.48 and 2.47 kg/m2 /min respectively which are within the limits of 3-7 kg/m2 /min as reported by Basha and Kaushik (2014) with an average of 5.1kg/m2 /min and Co- efficient of 0.19. It can also see that the means value for BFA-1 is much higher than BFA-2 almost double and the mean value for BCB is in between the BFA-1 and BFA-2 The CV for BCB, BFA-1 and BFA-2 is 0.07, 0.05, 0.09 respectively.

3.2 Moisture absorption variation

Value for BCB varies from 15.02% to 16.32%, BFA-1 value varies from 16.20% to 16.98 % and for BFA-2 values in between 15.22% to 15.98 %. With a co efficient of variation 0.03, 0.01, 0.02 respectively. The mean value for BCB, BFA-1and BFA-2 is 15.67, 16.48 and 15.55 respectively which is lower than the permissible value specified by IS 12894:2002. And for fly ash bricks it is listed as 12.5 to 37 %.

The variation in the mean MA value for the BAF-1 is higher than the BFA-2 due to the reason of Fly ash content and its grading. More the finer grading of fly makes bricks denser and less moisture absorbent. Whereas for BCB bricks have silently higher value to BFA-2 reason may be the source of earth having silt content higher.

3.3 Dry Density Variation

The dry density for the BCB varies from 15.10-15.32 KN/m3, for BFA-1 its values are in between 15.01 -15.24 KN/m3 and for BFA-2 values are 16.21- 16.25 KN/m3. With a co efficient of variation of 0.01.

Dry density for the BCB, BFA-1 and BFA-2 bricks varies 15.10-15.32 ,15.01-15.23 and 16.10-16.32 KN/m3 respectively. Shows that the BCB and BFA-1 have lesser density w.r.t BFA-2 which is due to presence of less content of silica in BFA-1 and in BCB.

3.4 Crushing strength variation

The values for the BCB varies from 7.10-7.80 with a CV of 0.03 and for BFA-1 its value varies from 4.71-5.90 along with CV of 0.09 also for BFA-2 crushing strength varies form 9.50-9.87 with CV of 0.03.

As specified by many researchers' values for fly ash brick varies from 4.3-80 MPa and for clay brick value varies from 3.2-18.0 MPa, bricks used shows good quality and standard and data bound with the studies. Mean values also satisfy the same.

3.5 Crushing strength variation of mortar

The crushing strength value for the mortar variation can be easy observed form the table above that the mortar having higher cement content have high value of crushing strength. Total 15 cubes were tested three specimen of each kind C1 have the least amount of cement and C2 have the medium amount of cement and C3 have the maximum amount of cement. Rest all the condition of curing and other conditions kept same for all the samples.

The Co efficient of variation for C1 and C2 are 0.15 where for C3 is .016. Shows the variation in result is not much influencing. The variation in value in C1 mortar is from 8.54-5.85, for C2 is 12.54-8.50, and for C3 it varies from 23.56- 17.98 MPa. Shows that higher cement content results higher strength.

3.6 Crushing strength variation of masonry units

Four Bricks units are casted using three brick varieties using three different mortar mixtures, five sets of every unit are tested and results are formulated in individual table. A graft representing individual unit mean strength is shown.

a.) The crushing value of masonry unit in MPa for BCB which varies from 3.2-1.56, 3.56-2.45 and 4.65-3.12 for C1, C2and C3 respectively with a Co efficient of variation of 0.31, 0.19 and 0.17. The mean values shows that the BCB C3 has maximum mean crushing strength value of 3.80 MPa.

b.) The crushing strength table of BFA-1 shows the sample with different cement proportion have variation of value from 2.56-1.25 for C1 with CV of 0.3, for C2 values are from 3.50-2.23 with CV of 0.17 and for C3 crushing values are 4.56-2.78 MPa with CV of 0.19. Where the mean crushing strength value shows the BFA-1 with C3 mortar shows the maximum value of crushing strength of 3.73 MPa and BFA-1 with C2 mortar gives the value of 2.90 MPa and BFA-1 with BFA-1 with C1 yield the minimum value of 1.96 MPa.

c.) The crushing strength table of BFA-2 shows the sample with different cement proportion have variation of value from 2.78-1.45 for C1 with CV of 0.31, for C2 values are from 4.56-3.51 with CV of 0.11 and for C3 crushing values are 5.54-4.56 MPa with CV of 0.07. Where the mean crushing strength value shows the BFA-2 with C3 mortar shows the maximum value of crushing strength of 5.11 MPa and BFA-2 with C2 mortar gives the value of 3.86 MPa and BFA-1 with BFA-1 with C1 yield the minimum value of 2.10 MPa.

4. CONCLUSION:

It is concluded that

BFA-1 has more value than BFA-2 and BCB bricks.

2. BFA-2 has less moisture absorption value than BFA-1 due to more percentage of fly ash.
3. Dry density for BFA-2 is highest among BFA-1 and BCB due to high specific gravity of fly ash.
4. BFA-2 has highest crushing strength as compare to BFA-1 and BCB.
5. Crushing strength for mortar C3 has good strength as compared to C1 and C2.
6. As pozzolanic material reacts with cement in better way and results in good strength the co efficient of variation for masonry unit has least variation in CV
7. The crushing strength trend for the masonry unit shows that as the mix proportion of mortar increases the crushing strength of unit increases and among all BFA-2 has the highest value on C3.

5. ACKNOWLEDGEMENT:

The authors are thankful to Department of Civil Engineering, Vivekananda Global University, Jaipur (Rajasthan) India for providing necessary facilities to undertaken the studies.

Table no. 1. IRMA VARIATION

	IRMA ($kg/m^2/min$)		
Sl. No.	**BCB**	**BFA-1**	**BFA-2**
1	3.56	4.89	2.12
2	3.45	4.52	2.78
3	3.62	4.65	2.21
4	3.40	4.23	2.25
5	3.23	4.78	2.36
6	3.25	4.12	2.58
7	3.41	4.36	2.54
8	3.89	4.63	2.45
9	3.95	4.25	2.85
10	3.78	4.35	2.60
Mean	3.55	4.48	2.47
σ	0.24	0.24	0.23
CV	0.07	0.05	0.09

Table no. 2. Moisture absorption variation

	MA		
Sl. No.	**BCB**	**BFA-1**	**BFA-2**
1	15.23	16.21	15.26
2	15.56	16.56	15.23
3	15.46	16.54	12.65
4	15.02	16.36	15.45
5	15.24	16.52	15.22
6	15.89	16.20	15.65
7	15.98	16.32	15.68
8	16.00	16.55	15.48
9	16.02	16.58	15.98
10	16.32	16.98	15.89
Mean	15.67	16.48	15.55
SD	0.43	0.23	0.27
CV	0.03	0.01	0.02

Table no. 3. Dry Density Variation

	Dry Density		
Sl. No.	**BCB**	**BFA-1**	**BFA-2**
1	15.14	15.01	16.11
2	15.11	15.03	16.29
3	15.10	15.02	16.10
4	15.12	15.02	16.19
5	15.30	15.24	16.21
6	15.12	15.23	16.12
7	15.16	15.12	16.24
8	15.20	15.16	16.28
9	15.13	15.10	16.32
10	15.32	15.11	16.32
Mean	15.17	15.10	16.22
SD	0.08	0.09	0.09
CV	0.01	0.01	0.01

Table no. 4. Crushing strength variation

	Crushing strength		
Sl. No.	**BCB**	**BFA-1**	**BFA-2**
1	7.10	4.71	9.65
2	7.21	4.73	9.23
3	7.23	4.79	9.65
4	7.25	4.78	9.21
5	7.35	4.98	9.32
6	7.32	5.23	9.23
7	7.40	5.65	9.45
8	7.60	5.30	9.65
9	7.80	5.65	9.78
10	7.50	5.90	9.87
Mean	7.38	5.17	9.50
σ	0.21	0.44	0.25
CV	0.03	0.09	0.03

Table no. 5. Crushing strength variation of mortar

Brick type Mortar	BFA-1		
Sl. No.	**C1**	**C2**	**C3**
1	1.25	2.23	2.78
2	1.56	2.65	3.25
3	1.89	2.89	3.87
4	2.56	3.23	4.56
5	2.54	3.5	4.2
Mean	1.96	2.90	3.73
σ	0.58	0.50	0.72
COV	0.30	0.17	0.19

	Mortar Crushing strength		
Sl. No.	**C1**	**C2**	**C3**
1	5.85	8.50	17.98
2	6.23	10.47	20.36
3	6.54	12.54	21.54
4	7.23	12.00	21.90
5	8.54	11.89	23.56
Mean	6.88	11.08	21.07
σ	1.06	1.63	3.39
CV	0.15	0.15	0.16

Table no. 6. Crushing strength variation of masonry units

a.) **BCB**

Brick type Mortar	BCB		
Sl. No.	**C1**	**C2**	**C3**
1	1.56	2.45	3.12
2	1.65	2.23	3.23
3	2.45	3.23	3.89
4	2.89	3.18	4.12
5	3.2	3.56	4.65
Mean	2.35	2.93	3.80
σ	0.73	0.56	0.64
CV	0.31	0.19	0.17

b.) **BFA-1**

Brick type Mortar	BFA-1		
Sl. No.	**C1**	**C2**	**C3**
1	1.25	2.23	2.78
2	1.56	2.65	3.25
3	1.89	2.89	3.87
4	2.56	3.23	4.56
5	2.54	3.5	4.2
Mean	1.96	2.90	3.73
σ	0.58	0.50	0.72
CV	0.30	0.17	0.19

c.) **BFA-2**

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