USE OF BRICK WASTE IN CONCRETE: A PRESPECTIVE

Sandeep kumar[1], Ritesh jain[2]

[1]student, college of agricultural engineering and technology, P.A.U, Ludhiana, Punjab, India
[2] Associative Professor, Dept. of civil Engineering, C.O.A.E.T, P.A.U, Punjab, India

---

Abstract - *Today construction cost is very high with using routine construction materials like cement, fine aggregate and coarse aggregate. Further the resources required for the construction industry are getting of limiting nature now days. The present study was planned for finding some alternative strategy to combat with the issue of these materials. Accordingly, use of brick waste material as a partial replacement of cement or fine aggregate or coarse aggregate was found out as a possible way out. Old Buildings in India produce lots of demolition waste which might be difficult to dispose off otherwise whereas same could be useful in partial replacement of coarse aggregates in mix concrete design. So a study was framed trying to study the viability by use of locally available waste brick bats in the production of concrete that might prove economical as well. Research in this field and positive results are crucial so as to continue all developments with least damage to surrounding environment and obtaining all infrastructures for services and convenience which are desired to get at an economical and in a greener way.*

1. INTRODUCTION

During the last two decades, many structures reached their design life times or were defected due to the use of non-conforming materials or bad construction execution. In addition, the presence of old demolished constructions resulting from modernization and urbanization may play a major role, further natural calamities like earthquake produces building wastes which is difficult to dispose off. In fact, tremendous quantities of construction and demolition wastes are produced every year. Actually, the waste storage disposals are becoming a serious environmental problem, especially for major big cities that lack disposal sites. In fact, crushed clay brick known as brick bats is not considered a recyclable material in the many regions as opposed to recycled concrete aggregate, so the question arises what to do with this waste which is emerging as one of the major problems for the urban areas. In order to solve this problem several experiments were conducted, the most effective experiment which helped to solve this problem considerably is using the brick waste as a partial replacement to coarse aggregate in concrete blocks, by which this waste is indirectly used again in construction purposes for construction of buildings or for construction of roads and bridges and from their the topic of our project arises which is variation in strength of concrete cubes with the addition of brick bats in them. So our study was planned to present a comprehensive report on the use of recycled aggregates and powder produced from clay brick demolition wastes in concrete industry. The main focus of the research is to present information regarding the use of brick bats in mix concrete design in order to explore the possible uses of these brick bats in structural applications. The assessment of different properties of using brick bats recycled aggregate in masonry units' production will be presented.

2. REVIEW OF LITERATURE

2.1 Poon And Chan (2006)

He investigated the possibility of using crushed clay brick as aggregates in sub-base materials. Clay brick generated from construction sites is usually delivered to landfills for disposal. With the limited landfill space in Hong Kong, there is an immediate need to explore the possible use of crushed clay brick as a new civil engineering material .The results indicated that the incorporation of crushed clay brick reduced the density, compressive strength and tensile strength of the paving blocks. Due to the high water absorption of crushed clay brick particles, the water absorption of the resulting paving blocks were higher than that of the paving blocks that did not incorporate crushed clay brick. Although it was found that crushed clay brick impaired the quality of the resulting paving blocks to a certain extent, the paving blocks using 50% crushed clay brick met the minimum requirements specified by AS/NZS 4455 and ETWB of Hong Kong (Grade B) for pedestrian areas. Furthermore, it was feasible to produce paving blocks prepared with 25% crushed clay brick that satisfied the compressive strength requirement for paving blocks (Grade B) prescribed by ETWB of Hong Kong for trafficked area.

2.2 C.S.Poon ,S.C.Kou & L.Lam(2002) also together conducted study about using waste clay brick beads. A series of tests were carried out to determine the properties of the bricks and blocks prepared with and without recycled aggregates. The test results showed that the replacement of coarse and fine natural aggregates by recycled aggregates at the levels of 25 and 50% had little effect on the compressive strength of the brick and block specimens, but higher levels of replacement reduced the compressive strength. However,

the transverse strength of the specimens increased as the percentage of replacement increased. Using recycled aggregates as the replacement of natural aggregates at the level of up to 100%, concrete paving blocks with a 28-day compressive strength of not less than 49 MPa can be produced without the incorporation of fly ash, while paving blocks for footway uses with a lower compressive strength of 30 MPa and masonry bricks can be produced with the incorporation of fly ash.

2.3 Akhtaruzzaman and Hasnat(2006) studied the use of crushed clay brick aggregate as a 100% replacement of coarse natural aggregate in concrete. In this they report the results of a comprehensive study to assess the feasibility of using crushed clay brick as coarse and fine aggregates in concrete masonry block production. The effects of the content of crushed coarse and fine clay brick aggregates (CBA) on the mechanical properties of non-structural concrete block were quantified. From the experimental test results, it was observed that incorporating the crushed clay brick aggregates had a significant influence on the properties of blocks. The hardened density and drying shrinkage of the block specimens decreased with an increase in CBA content. The use of CBA increased the water absorption of block specimens. The results suggested that the amount of crushed clay brick to be used in concrete masonry blocks should be controlled at less than 25% (coarse aggregate) and within 50–75% for fine aggregates.

2.4 Ali A Aliabdo & Hani H.Hassan1 conducted very essential test on influence of brick waste on concrete block strength. The brick wastes were crushed, sorted and classified into coarse and fine aggregates as well as powder (CBP). The first phase of the research focuses on the effect of incorporating recycled aggregates on physico-mechanical properties of paste, mortar and concrete. Non-traditional tests including X-ray diffraction (XRD), thermo-gravimetric analysis (TGA) and micro-structural analysis (MSA) were performed. The second phase of the program explores the effect of using recycled aggregates on properties of concrete masonry units. A total of 44 mixtures were utilized throughout the program. Results show cement paste when modified with 25% CBP achieves smaller pore size and lower weight loss under high temperature than reference paste. Furthermore, the use of recycled aggregates reduces the overall unit weight of concrete masonry units. Actually, modified concrete masonry units incorporating recycled aggregates achieve lower unit weight, higher thermal resistance and absorption rate than reference units. Although considerable strength reduction is noticeable by substitution, compressive strength levels meet the Egyptian specifications limitations. Critical replacement ratios are suggested to produce load bearing-concrete masonry units. Based on experimental evidences, it can be stated that the use of recycled aggregate and dust made of clay bricks is promising in many applications where the thermal resistance, cost and environmental aspects are imperative.

2.5 Sadek(2011).The physical and mechanical properties of solid cement brick manufactured with crushed clay brick as a recycled aggregate have been reported by **Sadek.** His study was based on twin tower attack, He showed the environmental effects which cause the burning of bulding material for long duration while the fuel of aeroplanes burnt for only 10 minutes. Later his study helped to conclude that use of brick beads in concrete material enhance the concrete properties to withstand with higher temperatures.

2.6 Marek, C. R. Gallaway, B. M. and Long, R. E (1971) Investigated that the (recycling is a process to change materials (waste) into new products to prevent waste of potentially useful materials

2.7 Khan and Choudhry (1978) studied on Economic conditions and lack of suitable natural aggregates seems to have resulted in brick being used as aggregate in developing nations before being used in developed ones.

2.8 Hansen T.C. (1986) studied on the use of recycling of concrete as aggregate & found that the density, compressive strength and modulus of elasticity of recycled concrete is less than normal concrete.

2.9 K.M Brook (1990) Concluded that the Clean broken brick of good quality can provide satisfactory aggregates, the strength and density of concrete depending on the type of brick; engineering and allied bricks when crushed make quite good concrete of medium strength.

2.10 Leonard John Murdock (1991) studied on LECA is a special type of clay that has been palletized and fired in a rotary kiln at a very high temperature. As it is fired, the organic compounds in the clay burn off forcing the pellets to expand and become honeycombed while the outside surface of each granule melts and is sintered.

2.11 L. J. Murdock (1991) studies on Pulverized fuel or fly ash (PFA**)** concluded that the residue of the combustion of pulverized coal used in the manufacture of lightweight aggregates in Germany and Great Britain to reduce dead loads of high rise structure.

2.12 Devenny and Khalaf (1999) studied that the earliest use of crushed brick in cementitious materials using Portland cement occurred in Germany in 1860). He said that in Europe, many of the buildings damaged or destroyed by bombs during World War II included brick masonry.

2.13 Brar M (1999) concluded that the methods of crushing of parent concrete has significant effect on recycled aggregate and partial shape of recycled aggregate is more irregular than normal concrete, recycled aggregate need more water than normal aggregate for same workability.

2.14 Sglavo et al. (1999) investigated two different clays used as basic materials, the former being currently employed for the production of bricks by extrusion, the second is almost pure Kaolin for high quality ceramic manufacturing.

2.15 N NARAYANAN (2000) studied on widely use of aerated concrete & concluded that it has high flow ability, low self-weight, controlled new strength, excellent thermal insulation and fire resistance.

2.16 Kutegeza and Alexander (2004) studied the standpoint of sustainability; use of recycled materials as aggregates provides several advantages. Landfill space used for disposal is decreased, and existing natural aggregate sources are not as quickly depleted.

2.17 Koyuncu H (2004) studied on use of recycled aggregate from the ceramic industry waste in the construction of land fill, sub based course on secondary road, concrete block and manufacture of concrete.

2.18 Tam and Tam (2006) studied on Use of brick waste materials as aggregates in concrete which c a n provide a number of advantages to stake holders including owners, contractors, and the ready-mixed concrete and precast concrete industries.

2.19 Ge et al. studied the effect of clay brick powder on concrete mechanical properties.

3. MATERIAL USED

3.1 Cement: It is a powdery substance made by calcining lime and clay, mixed with water to form mortar or mixed with sand, gravel, and water to make concrete. Cement used in this project is ordinary Portland cement. In our study we used OPC43 cement.

3.2 Aggregates:
Aggregates are inert granular materials such as sand, gravel or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. For this study we used river sand.

3.2.1 Coarse aggregates
Aggregates most of which retained on 4.75-mm BIS Sieve are known as coarse aggregates. The various types of coarse aggregates described as:

1. Uncrushed gravel or stone which results from natural disintegration of rock.
2. Crushed gravel or stone when it results from crushing of gravel or hard stone.
3. Partially crushed gravel or stone when it is a product of the blending of above two.

3.2.2 Fine aggregates

Aggregates most of which passes 4.75-mm BIS Sieve known as fine aggregates

1. **Natural sand** - Fine aggregates resulting from the natural disintegration of rock and which have been deposited by streams or glacial agencies.
2. **Crushed stone sand** - Fine aggregates produced by crushing hard stone.
3. **Crushed gravel sand -** Fine aggregates produced by crushing natural gravel.

3.3 Brick bats:
Brickbat is broken pieces of bricks". Bricks are more commonly used in the construction of buildings than any other material except wood. Brick bats are generally obtained from old damaged bricks. The broken pieces of bricks which pass the sieve of 20 mm size are considered as brick bats.

3.4 Water:
Fresh and clean tap water was used for casting the specimens in the present study. The water was relatively free from organic matter, silt, oil, sugar, chloride and acidic material.

4. CASTING PROCEDURE

In our research M15 concrete mix was designed from which total 54 cubes were casted and the casting of cubes was done in three halves on 3 different locations namely Ludhiana, Bathinda, Bhaddal and on different times so that the variation of season(time) as well as location may also be accounted for, if any. Each set of samples consisted of 18 cubes, further description of each set is-

- 18 concrete cubes were made each of 100 X 100 x 100mm dimensions.
- Out of 18 blocks, 2 cubes were without addition of brick bats as nominal blocks, one of which was tested after 7 days of casting and other at the gap of 28 days.
- Further remaining 16 blocks were made with usage of brick bats as coarse aggregates.
- Water cement ratio of 0.5 was planned (found using slump cone test)
- These 16 blocks were divided into 4 equal parts, each part containing 4 blocks of particular percentage of brick bats.
- Percentage on the basis of which they were divided was 5%, 10%, 15% and 20%. This was planned by reviewing the previous little studies found from research papers
- Moving forward every particular % was divided into two equal parts, each containing 4 blocks, in these 2 blocks were containing wet brick bats(brick bats were soaked overnight before inclusion into the cube) and other 2 were containing dry brick bats.
- From every particular percentage 1 dry block and 1 wet block was tested after 7 days along with the nominal mix.
- The remaining cubes were tested after 28 days of casting.

CUBE BEING FILLED

5. TESTING PROCEDURE

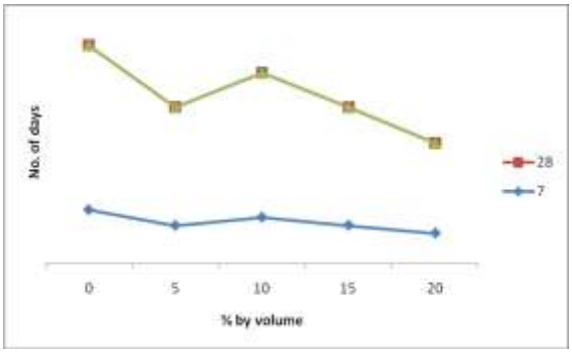
Specimens were taken out from the curing tank at the ages of 7 and 28 days. Surface water was wiped off and specimens were immediately tested after removal from the curing tank and air drying it.

The compressive strength of concrete cubes was tested under Universal Testing Machine (UTM) as shown in figure. The load was applied gradually without shock till the failure of the specimen occur and thus the compressive strength of concrete cubes was found.

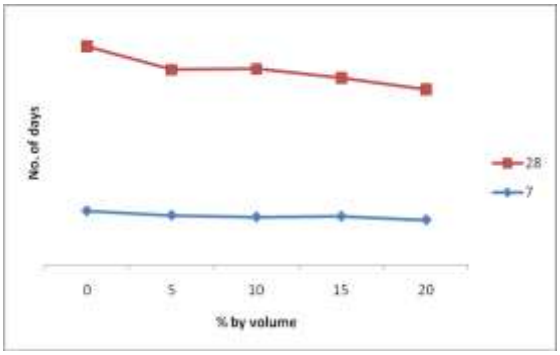
CUBE UNDER TESTING IN UTM

6. RESULT:

1. The replacement of coarse aggregates with brick bats significantly effect 28 days compressive strength of concrete.
2. Gradual increase of compressive strength of concrete upto 10% replacement of coarse aggregate with brick bats at all ages of curing. Beyond that there is significant reduction in compressive strength.
3. Replacement done with wet brick bats posses more compressive strength then replacement done with dry brick bats.



Dry Brick bats



Wet Brick bats

The replacement of coarse aggregates with brick bats beyond 10% has shown decrease in strength. Therefore, higher dosage of brick bats is not recommended. This is due to water absorbing capability of brick bats which disturbed the water-cement ratio.

Moreover the brick bats inclusion reduces compressive strength than the nominal mix but still upto 10% of inclusion of brick bats into the coarse aggregates will not hamper iyts usage to a greater extent besides the disposal of wastes and saving the environment as a whole.

7. CHALLENGES AHEAD FOR THE SOCIETY

Funds for civil research in India to make proper use of available resources and other waste in concrete design are of very small amount while the machines which are used to perform the test are of high cost and i, due to which sometimes proper research is not carried out.

The other challenge faced by society is inadequate availability of funds for management if however provided to the institute for this kind of work because the provision of funds for research in India is commonly observed to be made on an adhoc basis, and not allotted on the basis of any cost estimate which might be one of the biggest reasons for mismanagement of resources.

8. ISSUES OF GREAT CONCERN

The above statements therefore bring out few unaddressed and unresolved issues in Waste Management in India in most of the urban cities in India, more so in Metro cities in India. The issues may be enlisted as below:

1. Collection procedures (from source of origin and its transportation ahead)
2. Transfer of brick bats and other brick waste to end point.
3. Management Non Revenue Expenditure

9. CONCLUSION

Today we live in the world full of development and enthusiastic for still more comfort and facilities. This leads to innovations and revolutions in each and every field, but on contrary it has negative impact on environment as resources get depleted and pollution to different natural sources are occurred. So after studying all these research paper we concluded that if we can reduce or reuse some material in field of concrete production which is at its top now-a-days then it largely impact environment and leads to pollution free and soothing surrounding. And by using locally available wastes like brick bats , brick powder , quarry dust etc. as partial substitution at place of concrete ingredients, it may prove more economical than traditional concrete and question of damping of such waste produced by different industries is also get solved. Ultimate goal is to produce economical and eco-friendly concrete with all desired properties and strength which one obtains by regular concrete ingredients.

10. ACKNOWLEDGEMENTS

This work was supported and carried out with the services of college of agricultural engineering and technology, P.A.U, Ludhiana, Punjab, GZSCET Bathinda and IET Bhaddal. The authors are indebted for the help rendered..

REFERENCES

[1] A.Eisa (2014): "Properties of Concrete Incorporating Recycled Post-Consumer Environmental Wastes" International Journal of Concrete Structures and Materials Vol.8, No.3, pp.251–258.

[2] A.M Neville & J.J Brooks (2001): Concrete Technology; Pearson Education Limited, Edinburg Gate, England.Ahmad, S.I and Roy, S. (2011). "Effect of crushed clay brick as coarse aggregate on creep behavior of concrete." Advances in Building Materials, 261-263, 178-181.

[3] A.Seeni, Dr.C.Selvamony, Dr.S.U.Kannan, Dr. M.S.Ravikumar (2012) Experimental Study of Partial Replacement of Fine Aggregate with WasteMaterial from China Clay Industries International Journal of Computational Engineering Research (ijceronline.com) Vol. 2 Page 167.

[4] Akhtaruzzaman, A.A., and Hasnat, A. (1983). "Properties of concrete using crushed brick as aggregate." ACI Concrete International: Design and Construction, 5(2) 58-63

[5] Baronio, G., Binda, L., and Lombardini, N. (1997). "The role of brick pebbles and dust in conglomerates based on hydrated lime and crushed bricks." Construction and Building Materials, 11(1), 33-40.

[6] Chetna M Vyas (2013) Performance of Concrete with China Clay (Kaolin) Waste International Journal of Latest Trends in Engineering and Technology (IJLTET) Vol. 2 49-54

[7] "Code of practice for coarse & fine aggregates from natural sources for con-crete IS 383-1970, Bureau of Indian Standards, New Delhi.

[8] Code of practice for Strength of concrete IS 516-1959 Bureau of Indian Standards, New Delhi.

[9] Code of practice for Specification of portland cement IS 8112-1989 Bureau of Indian Standards, New Delhi

[10] Cachim, P.B., (2009). "Mechanical properties of brick aggregate concrete." Construction and Building Materials, 23, 1292-1297.

[11] DeVenny A. and Khalaf, F.M. (1999). "The use of crushed brick as coarse aggregate in concrete." Masonry International, 12, 81-84.

[12] Dr S L Pati, J N Kale , S Suman (2012) Fly ash concrete: a technical analysis for compressive strength international journal of advanced engineering research and studies Vol. No. 2 pp. 128-129