Experimental Study on Strength of Concrete with Partial Replacement of Fine Aggregate with Waste Clay Brick Powder

P Srinivas[1], A S S Vara Prasad[2], S Ashok Kumar[3]
[1, 2, 3] Department of Civil Engineering
[1, 2, 3] Kakinada Institute of Technology & Science, Divili.

Abstract- *Concrete is the most common used material for construction and their design consumes almost the totals cement production in the world. The use of large quantities of cement produces increasing CO2 emissions, and as a consequence the greenhouse effect. A method to reduce the cement content in concrete mixes is the use of silica fines. One of the silica fines with high potential as cement replacement and as concrete additive is Nano-silica (NS). This would save not only the natural resources and energy but also protect the environment with the reduction of waste material.*

The present work deals with addition of Nano-silica to concrete as partial replacement to cement in dosages of 1%, 1.5% and 2% by weight of cement. Based on early research M20 grade concrete has been chosen for this work. Addition of Nano-silica to normal cement concrete show increase in compressive strength and decrease in splitting tensile strength.

Keywords- Clay brick powder, Mix design, Compressive strength of concrete

I. INTRODUCTION

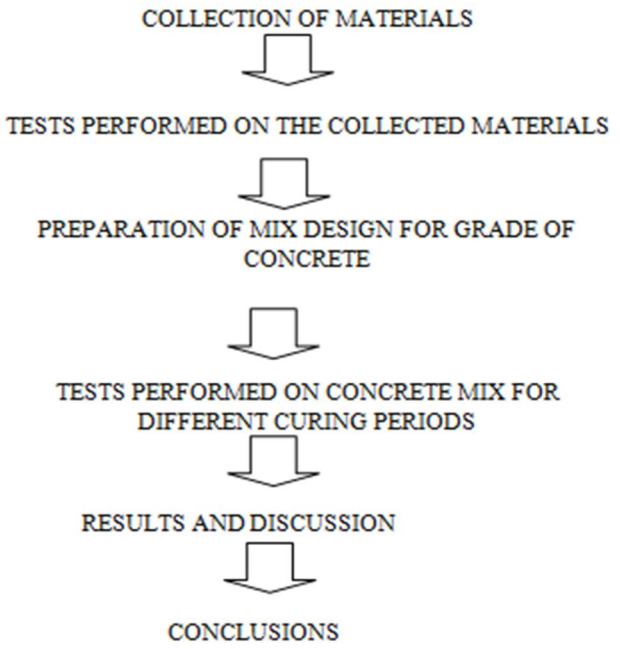
Concrete, as a constructive material becomes costlier due to raw material shortage. Therefore, developing novel technologies in production concrete is of great importance. Furthermore, large amount of wastage is produced during reconstruction of old building. Most of these wastages are not reusable or if they are, their recycling leads to wasting energy and pollution which in turn increases the environmental risk. Moreover, there is a need to develop strategy to achieve the twin aim of removing the wastage material and also obtaining the positive qualities of concrete

Recently, using new materials in concrete has become prevalent. Such materials are commonly used as a substation for aggregate or as a substitute for cement in concrete. This substitution is used as a strategy to help environment, reducing in budget and improving the features of concrete. Various studies have been achieved on using waste materials in concrete. Using glass, plastic, and ceramic tile are the examples of using waste materials in concrete. These waste materials can replace cement or aggregates in concrete. Some materials have the features of being used as pozzolan and some others can be used just as fillers or aggregates. Besides, using the waste materials of clay, brick has also been studied recently and usually positive impacts have been reported

The waste materials of clay bricks are usually come in different ways. Some are created in factories during and after the production process as a result of human mistakes, inappropriate materials, or a mistake in production process, some others are formed in transportation and distribution stage and finally a large part of waste materials are formed as a result of destroying buildings. The amount of waste materials may account to millions of tons annually. The nature of these materials is in a way that it is impossible to reuse them in the production cycle and therefore they are practically useless and as one type of building trash can pollute and damage environment. Therefore, finding strategies to use them can be rewarding. In a study, using brick aggregates in producing paving blocks has been investigated from which it has been concluded that using 25 percent of brick waste materials to produce paving blocks is acceptable. In another study, using clay brick waste materials along with concrete waste materials as aggregates in concrete were studied. Similarly, an investigation on the use of brick waste materials in light weight foamed concrete concluded that with the use of 25 percent of waste materials a suitable unit weight and resistance could be reached. In another study the use of the powder of clay brick waste materials as a substitution of cement were investigated. In this study the ASR were also dealt with. It reported that using brick waste materials as aggregate usually decrease the resistance and durability properties of concrete. However due to their being waste materials, their use has been reported to be positive. On the other hand, the usage of nano SiO_2 in concrete has been increasing in recent years.

III. METHODOLOGY

Materials used for the experiment study are Cement,Coarse aggregate ,Fine aggregate and Clay Brick Powder. Fine aggregate and passed through 4.75 mm sieve and retaining on 75 micron sieve were separated. Coarse aggregate passed through 20mm sieve and retaining on 12mm sieve were separated. In this study partially replaced 10%, 15%, 20%, and25% of natural sand with clay brick powder. The present study in aimed at utilizing clay brick powder as fine aggregate replacing natural sand partially and also the compressive strength of the water cured specimens is measured on the 3, 7, 21, 28 days using M25 design mix. In this study compare the compressive strength, with those of concrete made with natural fine aggregate and partial replacement of fine aggregate with clay brick powder.



Specific gravity test is performed on the collected materials like cement, coarse aggregate and clay brick powder the results are shown below. Tests performed on cement are Consistency, Initial setting time, final setting time and fineness of cement and the test results are shown below.

Table 1 Physical properties

Property of material	**Result**
Specific Gravity of Cement	3.2
Specific Gravity of coarse aggregate	2.7
Specific Gravity of clay brick powder	2.1
Bulk density of coarse aggregate	1689kg/m^3
Consistency of cement	29%
Initial setting time of cement	30min
Final setting time of cement	600min
Fineness of cement	9%

IV. RESULTS AND DISCUSSION

Compression test is the most common test conducted hardening concrete, partly because it is an easy test to perform, and partly because most of the desirable properties of concrete are qualitatively related to its compressive strength. The compressive test is conducted on specimens cubical or cylindrical in shape.

- The cube specimen is of the size 15*15*15 cm.
- M25 Mix proportions
- Cement - 396×0.0405 = 16.2 kg/m^3
- Water - 198×0.0405 = 8.1kg/m^3
- F.A - 616×0.0405 = 24.82Kg/m^3
- **C.A - 1139.4×0.0405 = 45.8055kg/m^3**

Table 2 Compressive Strength Results

Percentage replacement	Compressive strength of concrete (N/mm^2) for different curing periods (days)			
	3	7	21	28
0	13.57	21.83	31.54	33.1
10	14.35	22.23	32.33	34.15
15	15.84	23.25	34.13	36.18
20	16.05	26.13	34.87	37.18
25	13.01	20.89	30.53	32.77

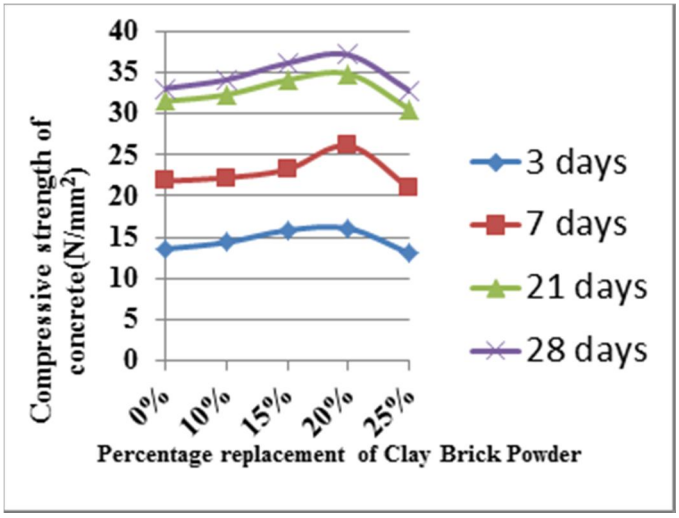


Fig 4.1: Compressive Strength verses Clay Brick Powder

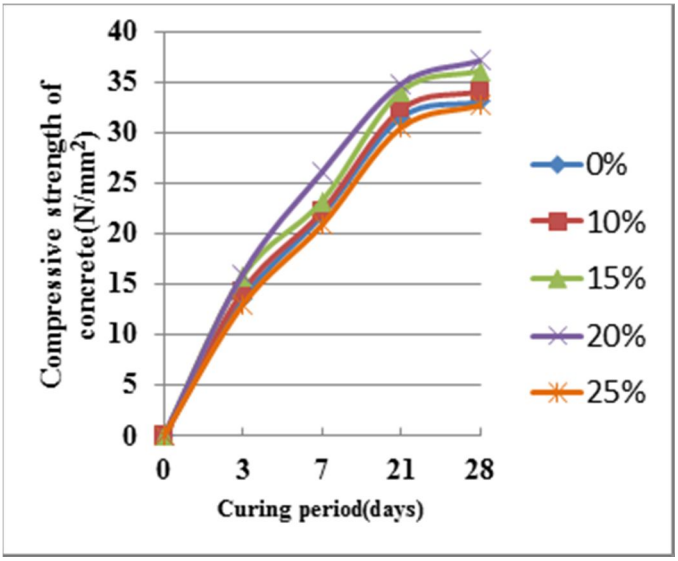


Fig 4.2: Curing Compressive Strength verses Clay Brick Powder

V. CONCLUSIONS

The replacement of fine aggregate by crushed brick powder is found to be very effective.

The optimum replacement is found to be 20% at which the strength of concrete at 3 days, 7 days 21 days & 28 days are higher than those of concrete prepared without replacement of sand.

Even at 25% replacement of sand, there is a marginal decrease in the achieved strength at 3, 7, 21 & 28 days compared to the 20% replacement but achieve the target strength of M25 grade concrete.

- The strength development pattern of brick powder concrete is similar to that of conventional concrete but there is increase in strength at all the curing ages.
- The utilization of mineral admixtures can be used to increase compressive strength at higher substitution levels.
- It serve economical and behave light in weight because of less unit weight.
- A good bond can be achieved between the brick aggregates and the cement paste, this is because the brick aggregates are angular that means they have a large surface area to bond with the paste.
- Up to 20% brick aggregate replacement for natural fine aggregate was found feasible and economical.
- The waste material of brick industry was efficiently used for the manufacturing of concrete.
- Its use as fine aggregate in concrete will help in alleviating the potential problem of dwindling natural resources.
- Its use will also help in protecting the environment surroundings.
- Brick dust is the potential viable material to be used as fine aggregate to produce durable concrete Till date a very limited research work on waste clay brick powder as aggregate in concrete has been carried out. Therefore further investigations to study the ways in which waste clay brick powder as aggregate replacement in concrete affects the rheological properties of fresh concrete, mechanical and durability properties of hardened mass are needed

REFERENCES

[1] A. Aliabdo, A. E. M. Abd-Elmoaty, and H. H. Hassan, “Utilization of crushed clay brick in cellular concrete production,” Alexandria Engineering Journal, Vol. 53(1), pp. 119-130, March (2014).

[2] BS12, Specification for Portland cement, London, Her Majesty Stationary office: British Standard Institution, 1996.

[3] BS1881-118, Method for determination of flexural strength, London: British Standard Institution, 1983.

[4] BS812-103.1, Method for determination of particle size distribution of aggregate – Sieve tests, London: British Standard Institution, 1985.

[5] BS882, "Specification for aggregates from natural sources for concrete," British Standards Institution, London, 1992.

[6] Climate Works Foundation, New Delhi, 2012.

[7] Concrete in National Conference on Cement and Building Materials from Industrial Wastes, LONDON, 1992.

[8] Demir, and M. Orhan, “Reuse of waste bricks in the production line,” Building and Environment, Vol.38 (12), pp. 1451-1455, May 2003.

[9] Dr. D. V. Prasada Rao and G. V. Sai Sireesha, “A Study on The Effect of Addition of Silica on Strength Properties of Partially Used Recycled Coarse Aggregate Concrete "International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 6, 2013, pp. 193 - 201, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[10] E. R.Singh, E. R.Kaushik, and E. G. Singh, "Study of Self Compacting Concrete Using Brick Dust and Marble Powder," International Journal of Engineering Research and Applications, Vol.3.3,pp. 1283-1286,

[11] Ghassan Subhi Jameel, "Study The Effect of Addition of Waste Plastic on Compressive And Tensile Strengths of Structural Lightweight Concrete Containing Broken Bricks as A coarse Aggregate" International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 2, 2013, pp. 415 - 432, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[12] impact of the use of white ceramic powder on the mechanical properties of concrete. Biosystems Engineering, 96, 559-564.