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RECYCLING OF USED WASTE BRICK BATS AND FLY ASH IN CONCRETE AS A PARTIAL REPLACEMENT FOR CONVENTIONAL INGREDIENTS

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Abstract

The partial substitution of excess waste brick bats as natural fine aggregate in concrete is discussed in this work. Due to improper drying, inadequate brick transportation management, etc., waste brick bats are produced.

Tests are run to determine the effects of replacing natural fine aggregate with waste brick bats by percentages of 0%, 10%, 20%, 30%, 40%, and 50%. Three flexural beams and 90 pieces total of 150mm concrete cubes with replacement mixes in five different percentages are cast and tested.

According to experimental findings, 25–30% of waste brick bats may be substituted with regular and mass concrete without compromising quality.

Keywords : Waste Brick Bats, Fly Ash, sustainable Concrete, Compressive Strength, Flexural Strength, Splitting Tensile Strength, Slump.

Introduction

The united Nations Department of Home Affairs projects that by 2050, there will be 9.5 billion people on the planet [1]. Reinforced Cement Concrete (RCC) has therefore become more important due to its many benefits in order to meet the infrastructure needs of such a fast population. In order to conserve the ecology, local authorities have banned the mining of fine aggregates from water bodies. Natural Fine Aggregate (NFA), also known as sand, is a crucial component of concrete but is currently in limited supply owing to its excessive usage. It is crucial to think of a new source of or replacement for natural fine aggregate as a result. This goal guided the design of the current study, which aimed to replace a particular proportion of Natural Fine Aggregate (NFA) with Brick Bats Waste. For economic, environmental, and technical reasons, the use of industrial waste materials produced by diverse industrial operations has become more significant, and there is increased research interest in regulating in regulating those waste products. So, in the current study, emphasis was placed on the reuse of powdered waste brick bats and in the creation of concrete.

[1] Most industrial processes in India create significant volumes of waste materials as by-products, including plastic trash, fly ash, demolition debris, and brick bat waste. In the current climate, institutions and academics are quite concerned about now to dispose of such by-product waste products from many different industries. A variety of factors that contributed to the majority of under-performing sites included brick bats waste. There were issues with the delivery of supplies at a number of locations, such as the inability to control of quality of bricks actually supplied and the destruction of bricks during the unloading processes. [3] It was shown that the main causes of brick bats waste were improper handling and transportation. Due to the designs lack of modular coherence, cutting bricks was another source of waste. Around this time 2% to 3% of the discarded brick bats were found for small building construction projects. [2] Using demolition and industrial waste in the manufacturing of concrete is a constant efforts. As well as providing a solution to the problem of waste disposal, such initiative can result in a decrease in overall building cost. The ecology may be preserved and the lack of natural sand can be lessened by using such a sustainable technique.

[4]Finding suitable replacement for natural fine aggregates is a continuous effort on the part of researchers and industry professionals. [5]One of the biggest environmental challenges is how to dispose of fly ash (FA), which is produced by the sugar and coal industries.

The issues become increasingly challenging to fix as FA production grows and landfill space capacity declines. Thus, research has been done to explore if high-volume fly ash (HVFA) may be utilized as a cement alternative in building materials in order to intervene in this waste disposal problem. In his review article, Rashad [6] discussed earlier research on the partial replacement of fly ash in concrete.

Researchers have not thoroughly examined the effects of using fly ash (FA) and waste brick bats as whole or partial replacement for concrete components [7-9]. Research was done to create precast concrete using fly ash [7]. For the purpose of illustrating how demolition debris may be used as a partial replacement or alternative, the authors have replaced natural fine aggregate with recycled fine aggregate in the proportions of 10-50% [10]. The results of the study show that concrete has increased in strength up to a replacement level. Neslihan [11] made the ecologically responsible choice to make construction material out of leftover foundry sand, fly ash. The study found that the geopolymer material, which was made from leftover foundry sand and fly ash, is suitable for use in building construction. Using foundry sand and fly ash, the experimental study’s goal was to produce flowable slurry mixes; the results show that the strength at 28 days ranged between 40 and 90 psi [12]. Siddique and Khatib [13] did an experimental research to see if fly ash might be utilised in concrete. The natural fine aggregates were replaced with class F fly ash in amount of 35%, 45% and 55% by the authors. The results of the investigation showed that at all ages, substituting fly ash with sand raised the concrete’s nd partial replacement of traditional material with waste materials.In some of the trials they carried out to make the previous concrete, the scientists used fly ash to replace some of the cement (10-20%). The abrasion reduced as well as overall voids shrank, according to the study’s results [15].

Cement has been significantly replaced with fly ash, aiding in environmental preservation. A tonne of portland cement requires 25 tonnes of raw materials, therefore any such endeavours will produce around 1 tonne of greenhouse gases [16]. In their study [16], Venkatakrishnaiah and Shakthivel employed fly ash as a partial cement replacement, creating a suitable way to reduce greenhouse gas emissions. The importance of carbonation and alkalinity testing is greater than that of strength test alone in order to give a viable alternative to cement or natural fine aggregate. Medeiros et al. [17] planned to replace fly ash (10-30%) with cement in the mixture during an experimental examination. The authors concluded that adding or substituting fly ash in cement mass increases the rate of carbonation while decreasing alkaline cement mass after completing XRD studies.

By replacing part of naturally occurring fine sand and cement mass in concrete with fly ash and waste brick bats, the current study aims to recycle industrial waste. This endeavour may help to lessen the issue of natural sand scarcity, maintain the ecosystem, solve the issue of waste disposal and greenhouse emission, and produce sustainable concrete mix at the most affordable price.

Test Program

2.1 Material Used

In the current investigation, the following materials were used: Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), Natural Coarse Aggregates (NCA), Natural Fine Aggregates (NFA), or river sand, Waste Brick Bats (WBB), Fly Ash (FA), and water. Following are explanations of the specific characteristics of several materials,

2.1.1 Cement

Portland Pozzolana Cement (PPC) and Ordinary Portland Cement (OPC) of grade 43 were both used in this investigation. The OPC was evaluated in accordance with IS: (8112-1989) standards [18]. Additionally, the scenarios were tested using PPC that complied with IS: 1489-1991 (Part 1) [19]. The outcomes of the rigorous physical and mechanical tests done on cement are listed in Table 1.

Table 1: OPC and PPC's Physical attributes

Details of Properties	OPC	PPC	Standards Limits
Specific Gravity	2.85	2.68	-
Fineness (%)	1.22	1.72	≤ 10 %
Standard consistency	26	29	-
Initial Setting Time (mm)	95	60	≥ 30 min
Final Setting Time (mm)	340	170	≤ 600 min

2.1.2 Aggregates

In the aforementioned investigation, crushed aggregate with a minimum aggregate size of 20 mm that was readily accessible locally was employed. Table 2 displays the findings of several tests conducted to determine the characteristics of NCA in accordance with industry standards [20]. Fig. 1 displays the grain size distribution of the natural coarse aggregates used in this investigation. Concrete was made using the fine sand remained on the 150 sieve after passing through a 4.75 mm screen. The graded zone (IS: 383-1970) is where the sand sample is located [21]. Table 3 lists the physical characteristics of the fine sand utilised in this investigation.

Table 2: Coarse Aggregates (CA) Properties

Test carried for	Observed values
Fineness modulus	5.86
Specific gravity	2.55
Water absorption (%)	0.55
Bulk density (kg/m^3)	1632
Aggregate impact value (%)	19.90
Aggregate crushing value (%)	22.87
Voids %	145.56

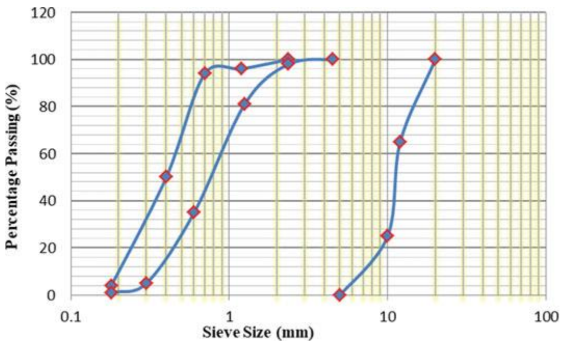

Fig. 1 Grain size distribution of aggregates

2.1.3 Waste Brick Bats and Fly Ash

Waste brick bats and fly ash were both sourced from Mohammadwadi, Hadapsar, Pune, Maharashtra for this project. The methods utilised in this study substituted waste brick bats for NFA in percentages of 10%, 20%, 30%, 40%, and 50%. The physical characteristics of wasted brick bats are described in Table 3. Fly ash was used to replace cement in the following ratios: 10%, 20%, 30%, 40%, and 50%. Table 4 lists the specific characteristics of fly ash in detail.

Table 3 Physical Properties of natural fine aggregate (NFA) and Waste Brick Bats

Details of Properties	Experimental values	
	NFA	Waste brick bats
Fineness modulus	3.64	2.89
Specific gravity	2.55	2.15
Grading zone	II	-
Water absorption (%)	2.0	6.26
Voids %	108.99	52.20
Bulk density	1155	966

Table4 Chemical Properties of fly ash (FA)

Items	Observed values
Al_2O_3 (%)	24
Si_2 (%)	50.23
Loss on ignition	2.01
CaO (%)	11.02
MgO (%)	3.00
Specific gravity	2.55
Initial setting time (mm)	50
Final setting time (mm)	300
Standard consistancy (%)	35

2.1.4 Water

Regular tap water was utilised in the current process to prepare the concrete. The experiment's water has a pH of 7.22.

When choosing a water sample, the guidelines in IS: 456-2000 [22] were used. According to the recommendations, the pH level may need to fall between (6.5-8.5).

2.2 Concrete Mix Design

M20 concrete has been utilised in this paper for analysis. The mix design used a water-cement (w/c) ratio of 0.54. Furthermore, following the instructions in IS:10262-2009 [23], the parameters of the component elements for various concrete mixtures were calculated. The previously mentioned percentage of waste brick bats and fly ash (FA) was used to replace some of the NFA and cement. The mixes that contained cement and 100% NFA were regarded as reference/control mixes. The graphic images show the comparison between mixes with 100% conventional ingredients and blends with partial substitution.

2.3 Concrete Testing

In order to determine the modified concrete's compressive strength, splitting tensile strength, and flexural strength, waste brick bats and fly ash were used in place of some of the traditional concrete's constituents. For the splitting tensile strength test, cylinders with a diameter of 150 mm and a height of 300 mm were employed, whereas a cube of dimension (150×150×150) mm was used for the compressive strength test. Additionally, beams with diameters of (100×100×100) mm were made in order to assess the flexural strength of concrete. The concrete samples were stored in normal water at room temperature in the laboratory set-up after demolding for curing reasons. The concrete specimens were evaluated after 7 and 28 days of wet curing in accordance with the recommended procedures [24, 25].

3 Results and Discussion

3.1 Compressive Strength

The compressive strength of concrete mixtures illustrates the viability and the upper bound at which recycled materials should be used in place of recylced materials (Figure 4). To assess the compressive strength in this experiment, concrete specimens were evaluated after 7 days and 28 days (Figs. 2 and 3). The results show that the compressive strength rises up to 30% when Waste Brick Bats are replaced with UFS, but it decreases after that point. Additionally, the findings reveal a rising tendency up to 30% when cement is replaced with fly ash (Figs. 4 and 5).

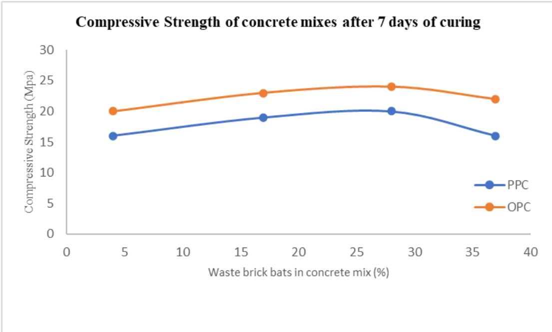

Fig. 2 Compressive strength of concrete mixes after 7 days of curing

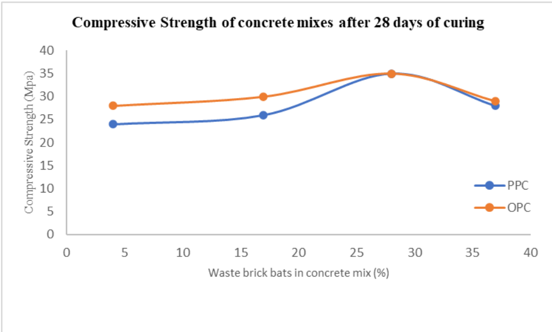

Fig. 3 Compressive strength (28 days)

Fig. 4 Testing of concrete specimens in laboratory

3.2 Flexural Strength

The material's stress before it yields is indicated by its flexural strength. Figs. 6 and 7, which demonstrate the fluctuation in flexural strength of various concrete compositions after 7 and 28 days, respectively. It also increased until the proportion of FS in the mix reached 30%, at which point it started to fall. Mixtures that replaced up to 30% of the NFA with waste brick bats demonstrated greater strength than control mixtures.

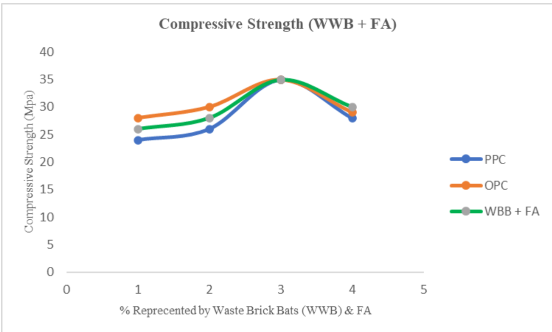

Fig. 5 Compressive strength (UFS + FA)

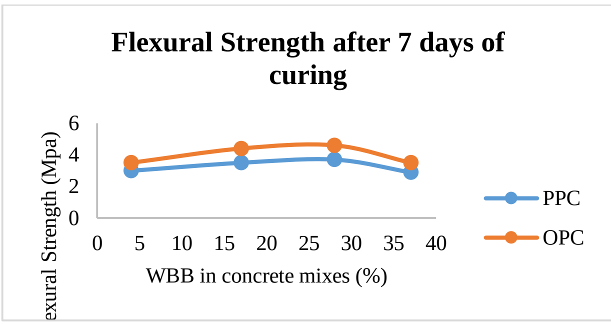

Fig. 6 Flexural strength (7 days)

After 28 days, the specimens showed, for OPC mixes while replacement proportion 15%, 25%, and 35%, the flexural strength was more than control mix by 5.67%, 10.72% and lower by 2%. Moreover, for PPC mixes, the flexural strength was 8.17%, 13.47%, and 6.25% more as compared to control mixes.

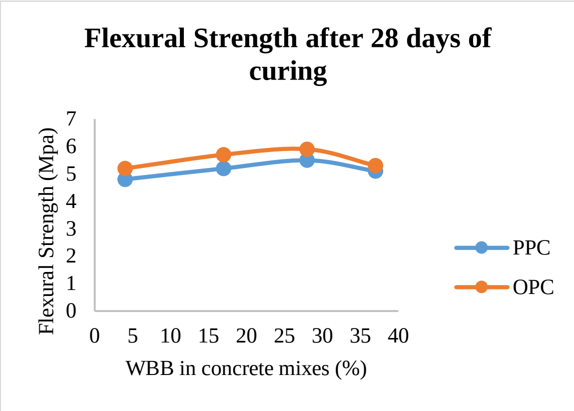

Fig. 7 Flexural strength (28 days)

3.3 Slump

In the present demonstration, it was shown that the slump of the concrete lowers when more recycled material is used to replace conventional concrete (Fig. 8).

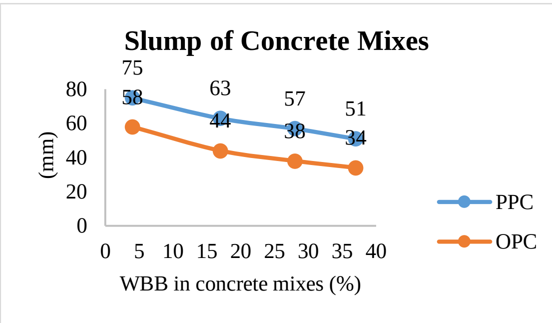

Fig. 8 Slump of concrete mixes

3.4 Splitting Tensile Strength

In trials, it was shown that adding waste brick bats boosted the splitting tensile strength of concrete by up to 30%; nevertheless, the mixes demonstrated lesser strength than control mixes at these amounts (Fig. 9). In the current study, after 28 days, NFA with Waste Brick Bats by 20% and 30% enhanced the splitting tensile strength for concrete mixtures by 9.45% and 12%, respectively, while 40% replacement resulted in a 15% decrease in strength (Fig. 10).

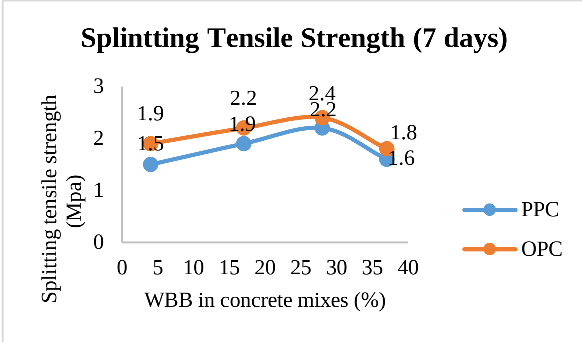

Fig. 9 Splitting tensile strength (7 days)

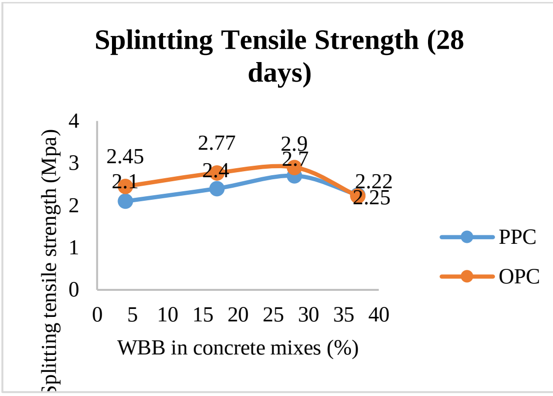

Fig. 10 Splitting tensile strength of concrete mixes after 28 days of curing

4 Conclusions

This study demonstrates and examines the use of waste brick bats in concrete mixes as a partial substitute for NFA, or sand. The following findings may be taken from this investigation.

- Workability decreases as the percentage of waste brick bats in the concrete mix increases for both OPC and PPC-based concrete mixtures..
- The strength of various mixes for both OPC- and PPC-based concrete mixes increased up to 30%

substitution of NFA by Waste Brick Bats and 30% substitution of cement by fly ash, but after this proportion, a declining tendency for strength was observed.

- In conclusion, waste brick bats can be used in place of natural fine particles in high-quality concrete mixtures without compromising strength. Fine aggregate preservation, garbage reduction, and ecological conservation are potential outcomes of this endeavour.

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