Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 3, No.2, March : 2025

PHYSICAL PROPERTIES OF CONCRETE USING OVER BURNT BRICK AGGREGATE AS A PARTIAL REPLACEMENT OF NATURAL COARSE AGGREGATE

Prof. S. D. Agrawal, Department of Civil Engineering, SSVPS's Bapusaheb Shivajirao Deore College of Engineering, Dhule, Maharashtra India
M. R. Patil, P.G. Scholar, Department of Civil Engineering, SSVPS's Bapusaheb Shivajirao Deore College of Engineering, Dhule, Maharashtra India

Abstract
This study investigates the potential of using over-burnt brick aggregates as a partial replacement for natural coarse aggregates in concrete. Over-burnt bricks, typically considered waste from the brick manufacturing process, are often discarded due to their reduced strength and poor appearance. However, this research aims to explore whether these discarded bricks, when processed into aggregate form, can be effectively utilized in concrete production without significantly compromising the material's quality. The primary focus is on the physical properties of concrete, including its compressive strength, workability, density, and durability, when over-burnt bricks are incorporated as a partial replacement for natural coarse aggregates. Various concrete mixtures are prepared with different replacement levels of over-burnt brick aggregates, and standard tests are conducted to evaluate how these mixtures perform.
Key factors such as the particle size, shape, and texture of the over-burnt brick aggregates are considered to determine their impact on concrete properties. Additionally, the environmental benefits of using over-burnt brick aggregates are also examined, particularly in terms of reducing waste and promoting the reuse of materials that would otherwise contribute to landfill.
The study aims to provide valuable insights into how over-burnt brick aggregates can offer a sustainable alternative to traditional natural aggregates, potentially lowering costs and reducing the environmental footprint of concrete production. Furthermore, the research will assess whether concrete made with these alternative aggregates can meet the required standards for construction projects, ensuring that it remains safe and durable for use in various applications.
Ultimately, the findings of this study could contribute to the development of greener and more resource-efficient construction practices, encouraging the use of industrial waste materials in concrete to promote sustainable building practices.
Keywords: Overburnt Brick, Aggregate, Concrete

I. Introduction

Concrete is a key material used in construction due to its strength in compression, although it is weak in tension. The main ingredients in concrete are cement, sand, coarse aggregate (such as gravel or crushed stone), and water. Changing any of these materials can affect both the cost and performance of concrete. Coarse aggregate makes up about 70% of the volume of concrete, but the cost of these aggregates is rising, and their availability is decreasing. Since aggregates are the most expensive part of concrete, finding alternatives is important.
One potential alternative is over-burnt brick bat (OBB) waste, which is created in brick manufacturing. OBB is typically found in sizes of 20-30mm and is often discarded as waste. Recent studies have shown that replacing some of the coarse aggregate in concrete with OBB waste does not significantly affect the strength or performance of the concrete, and it even reduces the weight of the concrete. This makes it a good option for use in large-scale concrete pours, such as in foundations or mass concrete projects.
From an environmental perspective, using OBB waste in concrete helps conserve natural resources. It reduces the need to mine raw materials, saves time and energy, and lowers the production of harmful greenhouse gases. The over-burnt bricks themselves are produced when bricks are exposed to excessive heat (above 1000°C) in the kiln. These bricks shrink, change color, and become red to

blackish in appearance. Instead of being discarded as waste, these over-burnt bricks can be repurposed in concrete, reducing the environmental impact of construction.

II. Aim and objective of the study

Many studies have already shown that over-burnt bricks can be used as a material in concrete. In this experiment, over-burnt bricks are used as a partial replacement for coarse aggregate in concrete. For this study, M20 grade concrete is used, and tests are conducted with different levels of over-burnt brick replacement (0%, 25%, and 50%) for the coarse aggregate. The results are then compared to standard concrete made with only coarse aggregate.

The main objectives of this study are:

1. To examine the properties of fresh concrete.
2. To test the compressive strength, flexural strength, and tensile strength of concrete when coarse aggregate is replaced with over-burnt bricks.
3. To analyse the cost of using over-burnt bricks in concrete.

III. Literature review

The study explored the use of crushed over-burnt bricks as an alternative to natural coarse aggregates in concrete. The physical properties of the crushed over-burnt bricks were tested, and the results showed the following values: 22.8% for the aggregate crushing value, 28.2% for the aggregate impact value, and 4.4% for water absorption. Concrete mixes were made using these crushed over-burnt bricks as coarse aggregates, with different water-cement ratios of 0.40, 0.50, 0.55, and 0.60. Concrete cubes were then tested for compressive strength. The results were compared to concrete made with river wash gravel, which is the standard coarse aggregate used in Makurdi, Nigeria, and nearby areas. The study found that concrete made with crushed over-burnt bricks and sand had a density between 2000-2200 kg/m³ and a compressive strength of up to 29.5 N/mm². In comparison, the concrete made with gravel and sand had a density between 2300-2400 kg/m³ and a compressive strength of up to 30.8 N/mm². It was also observed that by lowering the water-cement ratio from 0.60 to 0.40, the compressive strength of both crushed over-burnt bricks-sand concrete and gravel-sand concrete increased by more than 30%. The study suggests that using crushed over-burnt bricks as coarse aggregate is a good option when natural aggregates are not readily available, when high-strength concrete is not needed, or when the soil's bearing capacity is low. [1]

The study focuses on using an alternative material to replace the usual coarse aggregate (such as rock) in concrete. One such material chosen is over-burnt bricks. These bricks were selected because they are easily available from brick manufacturing areas. During the brick-making process, many bricks are rejected because they do not meet the required standards. A common issue is that some bricks are distorted due to uneven heating in the kiln. These rejected bricks could be reused as a source of coarse aggregate in concrete, which would help reduce waste and solve disposal problems.

This project examines the impact of using over-burnt brick bat as a partial replacement for coarse aggregate in concrete. It looks at how this replacement affects the mechanical properties of the concrete, both in its wet (fresh) and hardened (set) states. [2]

An experimental study was conducted to replace coarse aggregate in concrete with demolished brick aggregate. Coarse aggregate is an important material in concrete, typically made up of materials like gravel, crushed stone, and sand, along with cement and water. In this study, the only variable tested was the amount of stone aggregate replaced by brick aggregate, with replacement levels of 0%, 25%, 50%, 75%, and 100%. The results showed that using brick aggregate instead of stone reduced the concrete's unit weight and compressive strength. The study also suggested new ways to calculate the compressive strength and splitting tensile strength of concrete with mixed aggregates. Among the different replacement levels, a 25% replacement of stone with brick aggregate was found to be the most suitable in terms of strength and cost-effectiveness, making it ideal for moderately loaded

structures. A 50% replacement can be used in areas where the load is expected to be lower, but some challenges may need to be addressed through better management practices. [3]
The study explored using alternative materials, such as over-burnt brick chips and demolished concrete waste, to partially replace coarse aggregate in concrete. These materials are readily available at a much lower cost compared to traditional coarse aggregates. The study aimed to examine how the compressive and split tensile strength of concrete is affected when conventional coarse aggregate is replaced by 10% to 50% over-burnt brick chips and 10% to 50% demolished concrete waste.
For this study, 54 concrete cubes (150mm x 150mm x 150mm) and 54 cylinders (150mm x 300mm) were cast and tested. The cubes and cylinders were made with different percentages of over-burnt brick chips and demolished concrete waste. To improve the workability of the concrete, a plasticizer called SUPER PLAST-HS was added, making up 0.8% to 1% of the weight of the cement. The results showed that replacing up to 25% of coarse aggregate with over-burnt brick chips and up to 35% with demolished concrete waste had little impact on the concrete's properties, keeping them close to the properties of standard M25 grade concrete. The study concluded that over-burnt brick chips can be used as a replacement for up to 25% of the coarse aggregate, and demolished concrete waste can be used for up to 35% replacement in M25 grade concrete. This substitution leads to a slight reduction in the cost of coarse aggregates, with a 10% reduction for over-burnt brick chips and a 25% reduction for demolished concrete waste. [4]

IV. Methodology

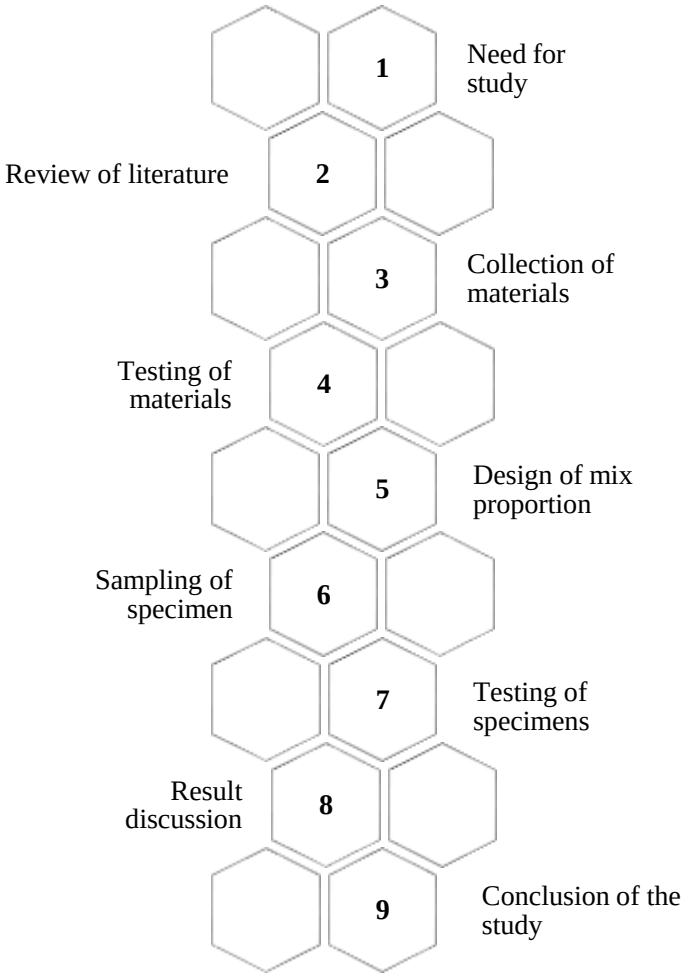

Figure 1: Order of methodology

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V. Experimental Analysis

Design specifications for Mix Design of M20 Grade Concrete as per IS 10262 – 2009 and IS 269 - 1976	
Grade	M20
Characteristic Compressive Strength @ 28 days	20 N/mm^2
Maximum size of aggregate	20 mm
Type of aggregate	Crushed angular
Maximum cement content	360 kg/m^3
Workability	50 mm
Degree of quality control	Good
Type of exposure	Mild
Degree of supervision	Good
Type of cement	OPC 53
Specific gravity of cement	3.15
Specific gravity of coarse aggregate	2.74
Specific gravity of fine aggregate	2.70
Water absorption of coarse aggregate	0.20 %
Water absorption of fine aggregate	2.98 %
Water absorption of overburnt brick	3.58 %

Table 1: Design Specifications

The concrete mix design for M-20 grade was prepared using different percentages of over-burnt bricks as part of the concrete mix. All the materials needed for making the concrete were weighed according to the required proportions. First, the dry ingredients were mixed together, and then water was added based on the design mix. The concrete was poured into standard molds in three layers. Each layer was compacted at least 25 times, and then the molds were vibrated on a vibrating table for two minutes. After this, the molds were placed on a flat surface in a damp environment for 24 hours. After 24 hours, the specimens were taken out of the molds and placed in clean water to cure for 7 and 28 days.

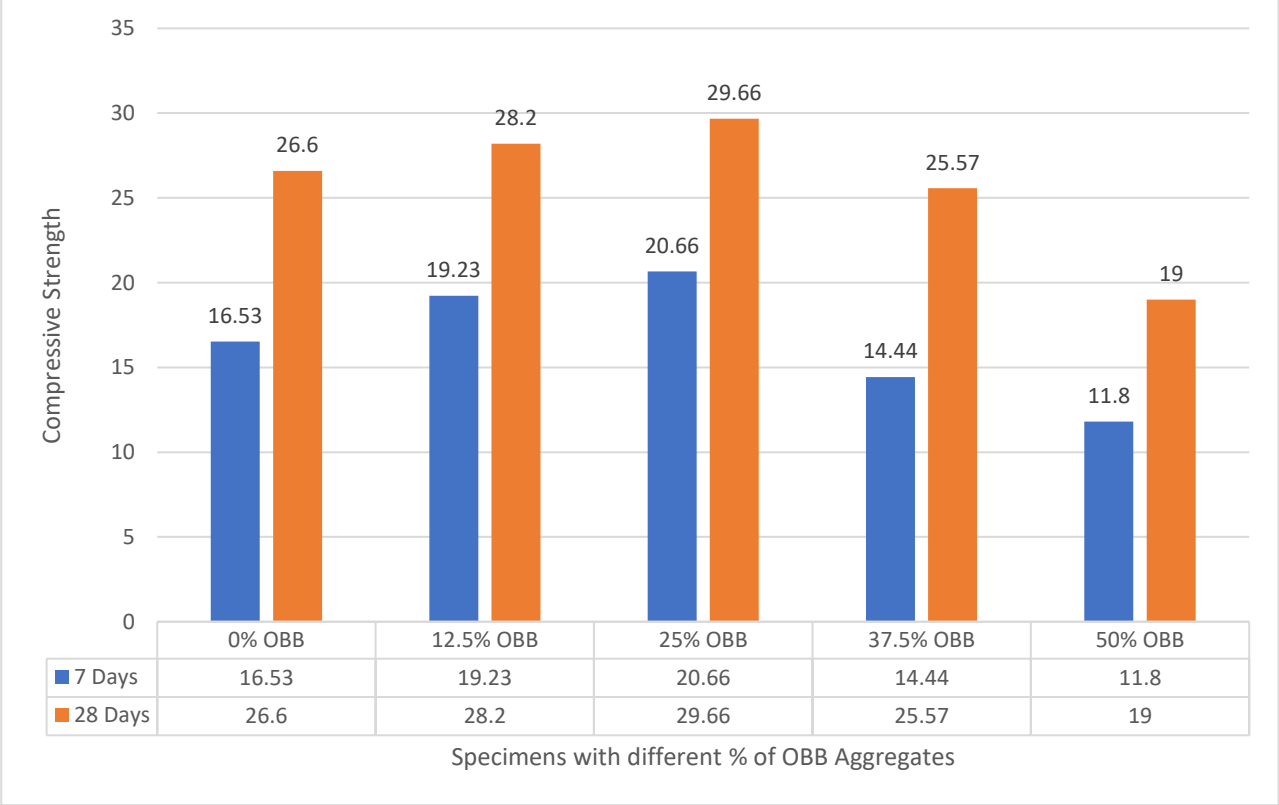

Figure 2: Comparison of compressive strength at 7 days and 28 days for 0% to 50% in N/mm

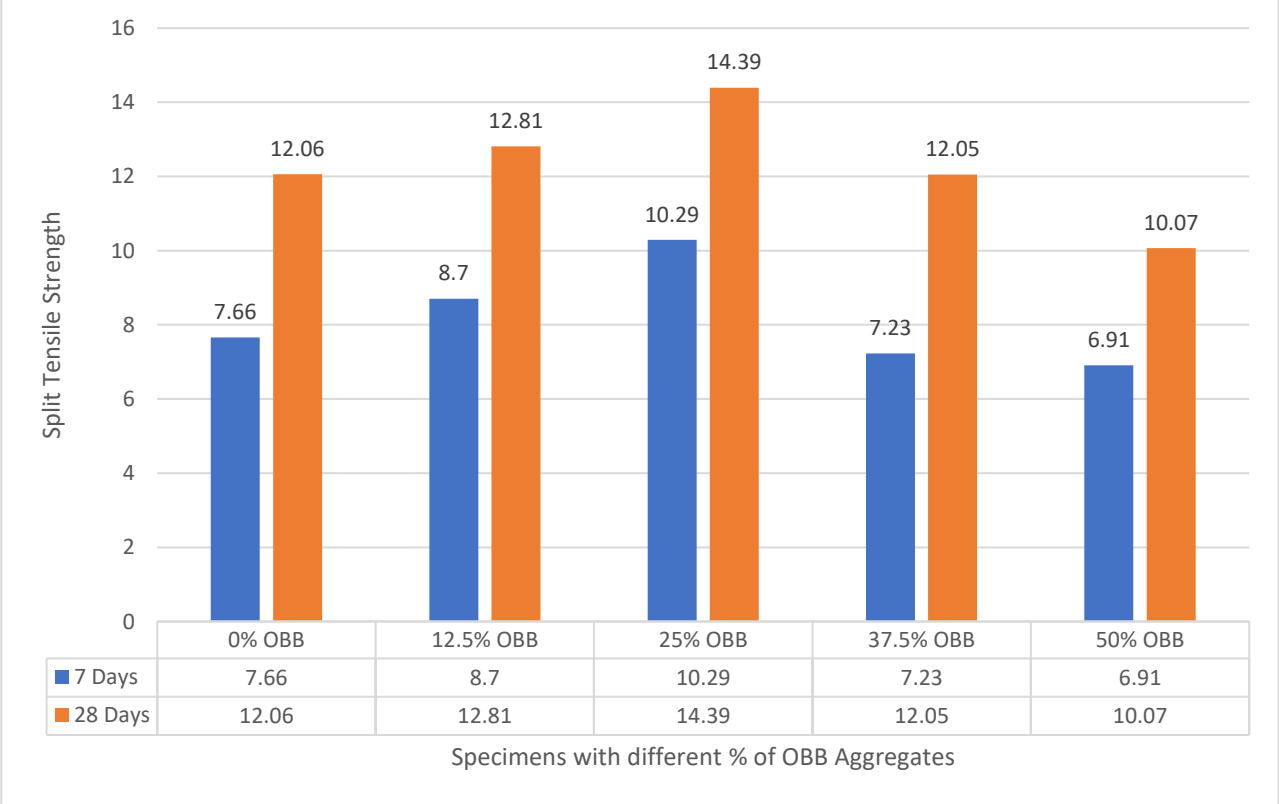

Figure 3: Comparison of spilt tensile strength at 7 days and 28 days for 0% to 50% in N/mm2

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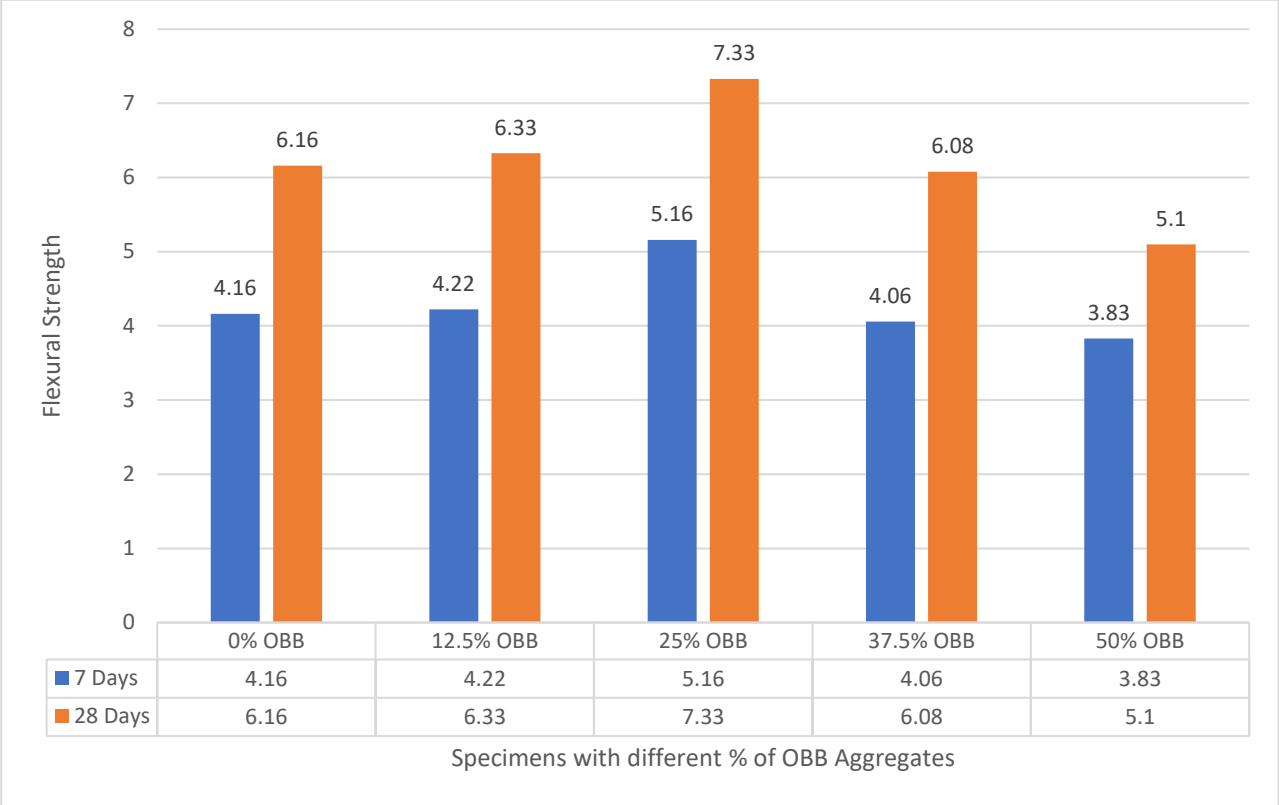

Figure 4: Comparison of flexural strength at 7 days and 28 days for 0% to 50% in N/mm2

VI. Result Analysis and Conclusion Discussion

This report presents the results of an experiment to test the feasibility of partially replacing coarse aggregate in concrete with over-burnt bricks. The study used M20 grade concrete, and the replacement percentages of over-burnt bricks were 0%, 12.5%, 25%, 37.5%, and 50%. The tests conducted included compressive strength, split tensile strength, and flexural strength tests to measure the effects of replacing coarse aggregate with over-burnt bricks.

Here are the key conclusions from the study:

1. As the percentage of over-burnt bricks increased up to 25%, the workability of the concrete was medium. However, for 37.5% and 50% replacement, the workability decreased, resulting in low workability.
2. The compressive strength increased by 6.01% to 11.50% when 12.5% to 25% of the coarse aggregate was replaced with over-burnt bricks. However, when 37.5% and 50% were replaced, the compressive strength decreased by 3.87% and 28.57%, respectively.
3. The split tensile strength of concrete with over-burnt bricks was higher by 6.25% and 19.32% for 12.5% and 25% replacement, compared to conventional concrete. For 37.5% and 50% replacement, the split tensile strength decreased by 0.08% and 16.50%, respectively.
4. The flexural strength of concrete with over-burnt bricks was higher by 2.75% and 18.99% for 12.5% and 25% replacement, compared to conventional concrete. However, for 37.5% and 50% replacement, the flexural strength decreased by 1.29% and 17.20%, respectively.
5. Replacing conventional concrete with over-burnt brick aggregate at 25% could result in a 3% cost saving.

In summary, replacing up to 25% of coarse aggregate with over-burnt bricks improves the strength and cost of concrete, but further replacement decreases its performance.

VII. Future Scope of the Study

The future scope of this study could involve several areas for further research and improvement:

1. Higher Replacement Levels: The study tested up to 50% replacement of coarse aggregate with over-burnt bricks, but more research could be done to test higher replacement percentages and explore how they affect concrete's properties.
2. Long-Term Durability: Future studies could focus on the long-term durability of concrete with over-burnt bricks, such as its resistance to weathering, freeze-thaw cycles, and chemical attacks.
3. Environmental Impact: Research could explore the environmental benefits of using over-burnt bricks, such as reducing waste from brick manufacturing and lowering the carbon footprint of concrete production.
4. Other Properties of Concrete: Future studies could test additional properties of concrete, like shrinkage, creep, and thermal conductivity, when over-burnt bricks are used as a partial replacement.
5. Optimization of Mix Design: Further research could focus on optimizing the mix design for concrete with over-burnt bricks to achieve the best balance of strength, workability, and cost-effectiveness.
6. Comparison with Other Waste Materials: It would be useful to compare the performance of over-burnt bricks with other waste materials (such as glass, plastics, or construction debris) as coarse aggregate replacements to identify the most suitable alternative.

By expanding on these areas, the use of over-burnt bricks in concrete can be better understood, making it a more sustainable and efficient material for construction.

References

[1] Apebo, N. S., Agunwamba, J. C., Ezeokonkwo, J. C., 'Suitability of crushed over burnt bricks as coarse aggregate of concrete,' International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3, Issue 1, January 2014.

[2] Bidve Ganesh Shivkanth, G. N. Shete, 'Experimental Study on Effect of Partial replacement of coarse aggregate by over burnt brick bats,' International Journal of Research in Engineering, Science and Management volume Issue4, April-2019.

[3] Dr. M. N. Hiremath, Mr. Sanjay S. J., 'Replacement of Coarse aggregate by Demolished Brick Waste in Concrete,' IJSTE - International Journal Science Technology & Engineering | Volume 4 | Issue 2 | August 2017.

[4] Kuldeepak Dwivedi, 'Study On Properties of Concrete Using Overburnt brick chips and demolished concrete waste as partial replacement of coarse aggregate,' IOSR Journal of Mechanical and Civil Engineering ,Volume 14, Issu e 6 Ver. I (Nov. - Dec. 2017)