**EXPERIMENTAL STUDY ON EFFECT OF PARTIAL REPLACEMENT OF COARSE AGGREGATE AS BRICK BALLAST AND FINE AGGREGATE AS BRICK ASH**

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**ABSTRACT:** Concrete is the most widely used material in infrastructure development and construction. world is concrete. Typical concrete mixtures are comprised of water, cement, fine aggregate and coarse aggregate in concrete. As the use of aggregates have been increased extensively there has been a scarcity in the availability of these materials. The non availability or shortage of fine aggregates and coarse aggregates will affect the construction industry. So there is a need to find out the alternative materials to replace the fine and coarse aggregates, so that no harm is done to the environment.

 Concrete mix was prepared by replacing the conventional coarse aggregate with brick ballast and fine aggregate with brick ash at different percentages such as 5%, 10%, 15%, 20% and 25% by their respective weights of coarse aggregate and fine aggregate. M25 grade concrete with 0.45 water to cement ratio has been used.

The workability and mechanical properties of concrete such as compressive strength and tensile strength were found after curing the concrete cubes and cylinders for 7, 14 and 28 days. After testing, result shows that there is an increase in both compressive strength at 5%, 10% and 15% of replacement with 32.453 N/mm2, 32.94 N/mm2 and 33.07 N/mm2 and tensile strength at 5% and 10% of replacements with 10.18 N/mm2 and 8.48 N/mm2 respectively compared to the conventional concrete cubes and cylinders

**KEY WORDS:** Brick ballast, brick ash, compressive strength and tensile strength.

**1.INTRODUCTION**

Concrete plays a vital role as a construction material in today’s world. It is easily obtained, relatively cheap, strong and durable. It is a composite material consists of cement, coarse aggregate, fine aggregate, water and admixtures in some cases. On the other hand, concrete industry is one of the major consumers of the natural resources.The demand for aggregate is enormous in liberalization, privatization and in the construction of important infrastructure projects.

The increased extraction of coarse and fine aggregate from natural resources is required to meet this high demand. The increasing use of natural aggregates creates ecological imbalance. Thus, One area of focus has been the exploration of alternative materials for concrete production, aiming to partially replace traditional aggregates with more eco-friendly options.

Coarse aggregate, which is obtained from natural resources such as gravel and crushed stone imposes a significant burden on the environment due to extraction and transportation. Similarly, the production of fine aggregate, sourced from the riverbeds or quarries contributes to ecological degradation. By recognizing the need for alternative materials, this study introduces the use of brick ballast for coarse aggregate and brick ash for fine aggregate as a partial replacement in concrete production.

This study aims to investigate the performance of concrete mixtures by partially incorporating brick ballast as a substitute for coarse aggregate and brick ash as a substitute for fine aggregate. The replacing materials are added in various percentages such as 0%, 5%, 10%, 15%, 20% and 25%.Through comprehensive testing and analysis including compressive strength and tensile strength, the study will evaluate the mechanical properties of the proposed concrete mixtures.

**2.METHODOLOGY**



1. **Collection of materials:** The materials have been collected from their respective sources. Such as ordinary portland cement of 53 grade from factory, fine aggregate from the riverbed, coarse aggregate from quarries, brick ballast and brick ash were from the brick kilns.
2. **Tests on materials:**

1.1 Cement:Ordinary Portland cement of 53 grade was used.The properties of cement were tabulated in the table 1

**Table 1**: Physical properties of cement

|  |  |  |
| --- | --- | --- |
| S.No | Properties | Test results |
| 1 | Fineness | 4.5% |
| 2 | Normal consistency | 34% |
| 3 | Initial setting time | 30 min |

1.2 Fine aggregate: The particles that passes through 4.75 mm sieve and retain on 0.075 mm sieve is Fine aggregate. The fine aggregate used here is locally available river sand. The sand is first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then washed to remove the dust. Properties of fine aggregate are tabulated in table 2.

**Table 2**: Physical properties of fine aggregate

|  |  |  |
| --- | --- | --- |
| S.No | Properties | Test results |
| 1 | Specific gravity | 2.52 |
| 2 | Fineness modulus | 2.98 |
| 3 | zone | III |
| 4 | Bulking of sand | 26% |

1.3 Coarse aggregate:. The nominal size 20 mm locally available coarse aggregate was used. The aggregates were washed to remove dust and dirt. Physical properties of coarse aggregate are tabulated in table 3.

**Table 3**: Physical properties of coarse aggregate

|  |  |  |
| --- | --- | --- |
| S.No | Properties | Test results |
| 1 | Fineness modulus | 3.3 |
| 2 | Specific gravity | 2.6 |
| 3 | Water absorption | 0.8% |
| 4 | Impact value test | 26% |

1.4 Water:Potable water available in laboratory was used for casting all the specimens. The quality of water was found to satisfy the requirements of IS:456-2000.

1.5 Brick Ballast: Brick ballast refers to a type of coarse aggregate used in construction and engineering applications. It consists of broken or crushed bricks that are typically sourced from demolition or brick kilns. The bricks are crushed into small, irregularly shaped pieces and then used as a component in various construction materials. Properties of brick ballast are tabulated in table 4

**Table 4**: Physical properties of brick ballast

|  |  |  |
| --- | --- | --- |
| S.No | Properties | Test results |
| 1 | Fineness modulus | 3.11 |
| 2 | Specific gravity | 2.53 |

1.6 Brick Ash:It is also known a brick ash or brick kiln ash, is a material that is generated as a byproduct of the brick manufacturing process. It is produced when bricks are fired in kilns at high temperatures, causing the organic and combustible components of the clay mixture to burn off, leaving behind residual ash. Physical properties of brick ash are tabulated in table 5.

**Table 5**: Physical properties of brick ash

|  |  |  |
| --- | --- | --- |
| S.No | Properties | Test reults |
| 1 | Fineness modulus | 2.67 |
| 2 | Specific gravity | 2.3 |

1. **Nominal mix and w/c ratio:** For this study, M25 grade of (1:1:2) concrete mix and water cement ratio of 0.45 has been adopted.
2. **Slump cone test:** The slump cone test is a widely used method to measure the workability or consistency of fresh concrete. It provides an indication of the flow and deformability of the concrete mixture. The test involves measuring the slump or settlement of the concrete when it is subjected to a specific amount of compaction.
3. **Casting of cubes and cylinders:** Freshly prepared concrete mix was casted into 18 standard cube moulds of dimensions 150mm × 150mm × 150mm and 18 standard cylindrical moulds of dimensions 150mm × 300mm with 0%, 5%, 10%, 15%, 20% and 25% partial replacement of brick ballast and brick ash. The top surface of the fresh concrete was levelled with the help of a trowel and the fresh concrete was allowed for 24 hours to set. The specimens were demoulded after 24 hours. All the moulds were cured by immersing in a curing tank in the lab.

**3.RESULT AND DISCUSSIONS**

**3.1 Fresh concrete analysis:**

**3.1.1 Slump test**

 The workability of fresh concrete was measured with standard slump cone. The test was performed immediately after mixing. Table 6 shows the slump values of concrete mix at defined replacements. Graphical representation of the slump test values are illustrated in graph 1.

**Table 6**: Slump test result

|  |  |  |
| --- | --- | --- |
| S.No | Brick ballast and brick ash content | Slump in mm |
| 1 | 0% | 94 |
| 2 | 5% | 97 |
| 3 | 10% | 104 |
| 4 | 15% | 98 |
| 5 | 20% | 89 |
| 6 | 25% | 97 |

**3.2 Hardened concrete analysis**

**3.2.1 Compressive strength**

The result of compressive strength after 7, 14 and 28 days are recorded. results indicate that the compressive strength has been gradually increased from 5% to 15% and then strength values are decreased simultaneously. Table 7 shows the compressive strength values at Various % of replacement for 7, 14 and 28 days. Graphical representation of compressive strength values are illustrated in graph 2.

**Table 7**: Compressive strength of cubes

|  |  |  |
| --- | --- | --- |
| S.No | % of brick ballast and brick ash | Average compressive strength in (N/mm2) |
| 7 days | 14 days | 28 days |
| 1 | 0% | 19.24 | 26.918 | 31.02 |
| 2 | 5% | 20.134 | 28.73 | 32.453 |
| 3 | 10% | 20.352 | 28.95 | 32.94 |
| 4 | 15% | 21.64 | 29.42 | 33.07 |
| 5 | 20% | 19.83 | 26.07 | 31.43 |
| 6 | 25% | 18.432 | 25.97 | 30.856 |

**Graph 2**: Compressive Strengths of Concrete for various % of Brick Ballast and Brick Ash after 7, 14 and 28 days

 **3.2.2 Tensile Strength**

The result of tensile strength after 7, 14 and 28 days are recorded. results indicate that the tensile strength has been increased at 5% and 10% and then strength values are decreased simultaneously. Table 8 shows the tensile strength values at various % replacement for 7, 14 and 28 days. Graphical representation of tensile strength values are illustrated in graph 3.

**Table 8**: Tensile strength of cylinders

|  |  |  |
| --- | --- | --- |
| S.No | % of brick ballast and brick ash | Tensile strength in (N/mm2) |
| 7 days | 14 days | 28 days |
| 1 | 0% | 7.92 | 8.2 | 8.36 |
| 2 | 5% | 7.01 | 8.96 | 10.18 |
| 3 | 10% | 6.38 | 7.7 | 8.48 |
| 4 | 15% | 3.96 | 6.79 | 7.35 |
| 5 | 20% | 5.66 | 6.7 | 6.79 |
| 6 | 25% | 5.1 | 6.22 | 6.7 |

**Graph 3**: Tensile Strength of Cylinders for Various % of Brick Ballast and Brick Ash after 7, 14 and 28 days

**4.CONCLUSION**

1. The Workability achieved is very good at different percentages of replacement such as 5%, 10%, 15%, 20% and 25%.
2. The Compressive strength of conventional concrete cube at 28 days of curing achieved is 31.02 N/mm2.
3. There is an increase in compressive strength at 5%, 10% and 15% replacement for 28 days of curing with 32.453 N/mm2, 32.94 N/mm2 and 33.07 N/mm2 respectively.
4. The split tensile strength of conventional concrete cylinder at 28 days of curing achieved is 8.36 N/mm2 .
5. There is an increase in Tensile Strength at 5% and 10% replacement for 28 days of curing with 10.18 N/mm2 and 8.48 N/mm2 respectively.

**5. REFERENCES**

1. Lakshmi and S. Niveditha , “Effect of partial replacements of aggregates by recycled concrete debris on strength of concrete”, Malaysian Journal of Civil Engineering, Vol. 27 (2), pp 250-259, 2015
2. Dinesh Kumar, G. Mohinuddin, M.Y. Haleem, M.A. An Experimental Study on Partial Replacement of Fine Aggregate with Coal Bottom Ash in Concrete. International Journal of Research Sciences and Advanced Engineering. 2(15), 2016, pp 39-49.
3. Kumar, N.S.T Siva, C. Use of Construction Renovation and Demolition Waste in Partial Replacement of Coarse Aggregate in M20 Concrete. International Journal of Research in Engineering and Technology, 4 (10), 2015, pp 375-378.
4. IS 383:1970, “Specification for Fine and Coarse Aggregates from Natural Resources for Concrete”, BIS, New Delhi.
5. IS 456:2000, “Plain Reinforced Concrete - Code of Practice”, BIS, New Delhi.
6. IS 10262:2019 Code book for mix design.
7. IS:2386 (Part III) - 1963 Code book for Methods of test for Aggregates for Concrete.
8. Concrete Technology by M.S.Shetty - S.Chand & Co.; 2004
9. IS 12269-1987, “Specification for 53 grade Ordinary Portland Cement”, BIS, New Delhi.