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Exploring Alternatives for Aggregates by Partially Replacing Mangalore Tiles and Flyash, Cement in Concrete

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Abstract - *The construction industry is increasingly seeking sustainable alternatives to traditional building materials to mitigate environmental impact. This study investigates the feasibility of partially replacing conventional aggregates in concrete with Mangalore tiles, fly ash, and cement alternatives. The aim is to develop a more environmentally friendly and resource efficient concrete mix without compromising structural integrity.*

The study also investigates the impact of Mangalore tiles as a partial replacement for coarse aggregates, considering their lightweight and unique thermal properties. Fly ash, a byproduct of coal combustion, is explored as a supplementary cementitious material to reduce the dependency on traditional Portland cement, thereby lowering carbon emissions associated with concrete production.

This paper deals with experimental study on the compressive strength and split tensile strength of M25 grade concrete with the partial replacement of fine and coarse aggregate by using Mangalore tiles. The sample are casted with fine aggregate 3% , 6% , 9% and 12% replacement and coarse aggregate 20% replacement and also partial replacement cement by fly ash 20% tested for 7 and 28 days strength with proper curing. The results show that upto 9% replacement level of fine aggregate attained workable concrete with satisfactory strength.

Key Words *Mangalore Tiles , Fly Ash , Chemical Admixture , Replacement material , Compressive Strength , Split Tensile Strength , Flexural Strength.*

1. INTRODUCTION

The use of more and more concrete in construction not only results in scarcity of materials but also turns out to be expensive. One such approach involves the Partially Replacing Mangalore Tiles and Flyash, Cement in Concrete , respectively. There are nearly 74 tile factories in the whole Dakshina Kannada district producing about 6000 patented Mangalore roof tiles per factory per day, out of which about 2% results as wastage. Coarse aggregates which occupy nearly 70 to 75% volume of concrete are sometimes referred as ingredients in more than one sense. Aggregates are in general cheaper than cement and impart greater volume stability and durability to concrete.

Fly ash is a fine powder that is a by-product of burning coal in power plants. It is made up of the non combustible parts of coal and a small amount of carbon that remains from incomplete combustion. Fly ash is usually light tan in color and consist mostly of glassy spheres that are silt-sized and clay-sized.

Overall, this experimental study provide insights into the feasibility and effectiveness of utilizing fly ash and mangalore tiles as partial replacements for cement, fine and coarse aggregate in concrete production. The findings of this research could potentially contribute to the development of sustainable construction practices, reducing the environmental impact associated with conventional concrete production while maintaining or improving the performance of concrete structures.

- **Experimental Objectives**

Important aspects of the work is to strengthen the concrete economically for structural applications by decreasing the aggregate content.

- This work demonstrates the suitability of Mangalore tiles and fly ash as partially replacement of aggregates in concrete.
- Studying the behavior of concrete, replacing cement by fly ash in different replacement percentage to get optimum results and using it for M25 grade of concrete. Same done for fine and coarse aggregate replacing Mangalore tiles.
- Studying the cost analysis of conventional concrete and proposed concrete with the respective grade of concrete.
- To contribute to the conservation of natural resources by utilizing a waste byproduct in construction materials.

2. LITERATURE REVIEW

Sivan Balasubramaniam.T.R. *et_al* (2018) : Have used mangalore tiles waste as coarse aggregate in concrete. Here they have used Fly ash as partially replacement to Ordinary Portland Cement. And compressive Strength and 15% the compressive strength has got increased. test (18.66 N/mm2 and 31.44 N/mm2 at 7 and 28 days) Split tensile strength test (3.02 N/mm2 and 3.92 N/mm2 at 7 and 28 days)

Flexural strength test (3.14 N/mm2 and 4.02 N/mm2 at 7 and 28 days). And the result is reduced as the percentage of replacement of Mangalore tile increases. And also the workability test on concrete of percentage is (0,10,20,30) and the slump value is (84,80,76,72)mm and compaction factor is (0.912,0.90,0.89,0.875) respectively. And the result of workability is decreased as the percentage of replacement of Mangalore tile increases. Finally in this study an attempt is made to investigate experimentally, the effect of Mangalore tile waste as aggregate in concrete. The compressive, split tensile and flexural strength is reduced as the percentage of replacement of Mangalore tile increases. The workability is decreased as the percentage of replacement of Mangalore tile increases.

Siddalingeshwara D H *et_al* (2019): Have used replacement of coarse aggregate by Mangalore tiles and sand by iron ore slag for M20 Grade Concrete. In slump cone test results indicate that the highest slump value is 80mm for 0% Replacement & The lowest value is 40mm for 40% Replacement. Compressive strength concrete results indicate that the highest value is 36.5 N/mm2 for 20% Replacement at 28 days and the lowest value is 18.02 N/mm2 for 40% Replacement at 7days. Split tensile strength concrete The highest value is 3.24N/mm2 for 20% Replacement at 28 days and the lowest value is 2.23 N/mm2 for 40% Replacement at 7 days. The Cost comparison of conventional concrete against proposed concrete is made in this section is total amount 5967 Rupees.

Jayanta Chakraborty *et_al* (2016) : Here the mainly deals with the concrete mix was designed for M25, M35 and M50 grade and the mix design was done as per IS 10262-1982 and IS 456-2000. The fly ash content percentage were produced, replacing 0% (reference concrete), 15%, 25%, 35%, 45%, 55% and 65% by the weight of cement. Here the cubes were cured for a time period of 7, 28 and 60 days. As per the compressive strength test we have conclude.

Shankh Agrawal *et_al* (2019) : Here the presents a view on grades of concrete selected for the study are M10, M20 & M30. The fly ash replacements considered for the study are 10% , 20% & 30% of cement by weight. The replacement of cement by fly ash in concrete to obtain their compressive strength in 7 , 28 , & 56 days. After we study on this paper , Use of fly ash improves the workability of concrete.

3. MATERIALS USED

The materials such as

- OPC 53 Grade Cement
- Fly Ash
- Fine Aggregate
- Coarse Aggregate
- Mangalore tiles
- Chemical Admixtures
- Water

3.1 CEMENT

The cement is a connecting substance. It complying to IS456-2000-53 grade. It comprised of milling the raw materials, blending them intently in certain proportion depending on such homogeneity and proportions burning them in a furnace at a temp of around 1350 – 1450 degree centigrade where at temperature, the content cinder and partially binds to construct stackable chapped clinker. The clinker is allowed to cool and crushed to a fine powder and additions of 2 to 3 percent of gypsum is done. Product created by utilizing this technique is Portland cement. Of all the components that impact the behaviour of concrete, cement is by far the most essential ingredient, since it is used to bond sand and aggregate so it withstands atmospheric action.

Properties of Cement

Sl. No	Properties	Values
1	Specific Gravity	3.00
2	Soundness	2 mm
3	Initial Setting Time	205 min
4	Final Setting Time	270 min
5	Consistency of Cement	32 %

3.2 FINE AGGREGATE :

The particles less than 4.75 mm size is considered as fine aggregates. River sand is mainly utilized as fine aggregate. In this exploratory research substitution of river sand was used as fine material.

Properties of Fine Aggregate

Sl. No	Properties	Values
1	Specific Gravity	2.63
2	Finess Modulus	2.892
3	Zone	II
4	Water Absorption	1.01 %

3.3 COARSE AGGREGATE :

Naturally obtainable properly graded granite aggregates of normal size larger than 4.75 mm but less than 16mm having fineness value of 2.71 was utilized as coarse aggregates.

Properties of coarse aggregate

Sl. No	Properties	Values
1	Specific Gravity	2.80
2	Finess Modulus	6.51
3	Crushing Strength	27.72
4	Water Absorption	0.301 %

3.4 Mangalore Tiles :

Mangalore tiles are a special type of clay roof tiles that come from Mangalore, India. They have a reddish color and unique shape. These tiles are really strong and can withstand different weather conditions. People love using them for roofing because they give buildings a traditional and charming look.

Mangalore tiles are made from natural clay, making them an eco- Department of Civil Engineering, MIT MYSORE Page 3 friendly roofing option. They are also recyclable and do not contribute to environmental degradation.

Properties of Mangalore tiles as FA

Sl. No	Properties	Values
1	Specific Gravity	2.71
2	Finess Modulus	3.75
3	Zone	II
4	Water Absorption	7.6%

Properties of Mangalore tiles as CA

Sl.No	Properties	Values
1	Specific Gravity	1.95
2	Finess Modulus	4.8
3	Crushing Strength	43.29
4	Water Absorption	17.04%

3.5 FLY ASH :

It is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases.

Properties of Fly ash

Sl. No	Properties	Values
1	Specific Gravity	2.225
2	Finess Modulus	4 ^{2}/kg

4. MIX DESIGN

Fabrication of excellent concrete demands painstaking care exercised at every step of making of concrete. If meticulous attention is not applied, and proper guidelines are not observed, the final concrete is likely to be bad concrete. Thus, it is vital for anyone to understand what are the excellent regulations to be observed in each step of manufacturing of concrete for generating high standard concrete.

4.1 Batching

Batching is the right procedure of metering the materials. For critical concrete, always, weigh batching method should be utilized. Use of weighing method in batching, enhances the accuracy, adjustability and convenience. Varieties of weigh batchers are accessible, the precise type to be selected, relies upon the kind of task. When weigh batching is implemented, the assessment of water must be done precisely utilizing measure jars.

4.2 Blending

Hand blending is done for relatively small concrete jobs. Manual blending must be done on an impermeable concrete or brick surface of sufficiently big size to accommodate one bag of cement. Spreading out the determined amount of coarse aggregate and fine aggregate in alternating layers. Pour the cement over the top of that though, and blend them thoroughly by shovel, turning the combination over and over until the homogeneity of hue is achieved. This homogenous combination is laid out in a thickness of around 20 cm.

This procedure is performed until such a good time a nice regular, homogeneous concrete is created. It is a special necessity to verify that perhaps the water is not poured but it is merely sprayed. At that moment, even a tiny amount of water makes difference. Afterwards the red soil is inserted in concrete at the varied proportion of concrete and lime powder is also added to the mix at half of the amount of red soil.

4.3 Positioning

It may not be sufficient that perhaps a concrete mix which is correctly designed, batched, blended is of highest significance. The concrete should be laid in

organized way to produce optimal outcomes. The measures should be taken and ways adopted when laying concrete in the castings.

4.4 Tamping

Manual pounding of concrete is employed in event of minor concrete works. Generally, this approach is also employed in such circumstances, when a big amount of reinforcing is employed, which cannot be usually compressed using conventional tools. Manual compaction comprises of rodding, pounding or hammering. When manual compaction is utilized, the homogeneity of concrete is preserved at a high degree. Tamping has been one of the common strategies utilized in compacting roof or subfloor or roadway pavements when the thickness of concrete is considerably less but the ground to be completed is smooth and flat.

4.5 Curing

Concrete gains its capacity through the hydration of cement molecules. The cement hydration is just not an instantaneous activity but a cycle lasting for lengthy time. More precisely, it may be stated as the technique of preserving a suitable amount of moisture and an optimum warmth in concrete at the time of placement and shortly upon installation, whereby the hydration of plaster may persist until the required qualities are evolved to a considerable degree to fulfil the criteria of utility. The moulded squares and cylinders are submerged in water barrels for 7 days and 28 days.

5. EXPERIMENTAL INVESTIGATIONS

Compressive Strength Test:

The typical cast of size 150mm × 150mm x 150mm is adopted for moulding. Curing is carried for 7 and 28days for concrete cube specimens and the strength test is performed in CTM (Compression testing machine) according to IS 516:1959 for conventional mix and for the substantial substituted samples.

Split tensile strength test:

The typical casting of dimensions 150mm × 300mm is utilized for auditioning. Curing is performed for 7 and 28 days. Split tensile test was performed in testing machine (CTM) as per IS 5816:1999 for regular mixture and for the partially supplemented samples.

Flexural strength test:

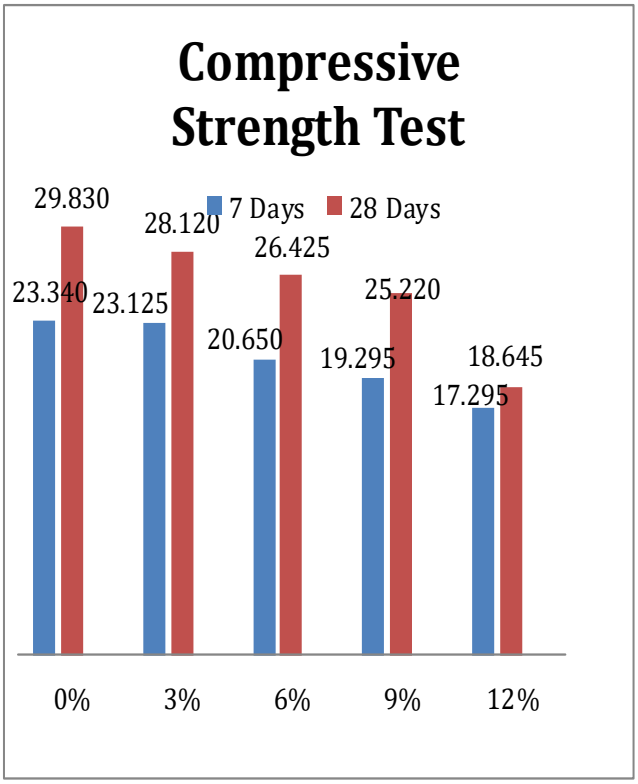
The basic mould of dimensions 750mm × 150mm × 150mm is being used for moulding. Curing is conducted for 7 and 28 days. Flexural strength test is conducted as per IS 516:1959 in universal testing machine (UTM) for usual mix and for the half-substituted samples.

6. EXPERIMENTAL RESULTS

The outcomes completed in the present study are reported in the style of Graphs and Charts for fly ash as a replacement of Cement by 20% and varied percentage of Mangalore tiles as a replacement to Fine and Coarse aggregates. The preceding is the percentage replacement of concrete i.e. the fine aggregate is 3 , 6 ,9 and 12 percent and coarse aggregate is 20 percent.

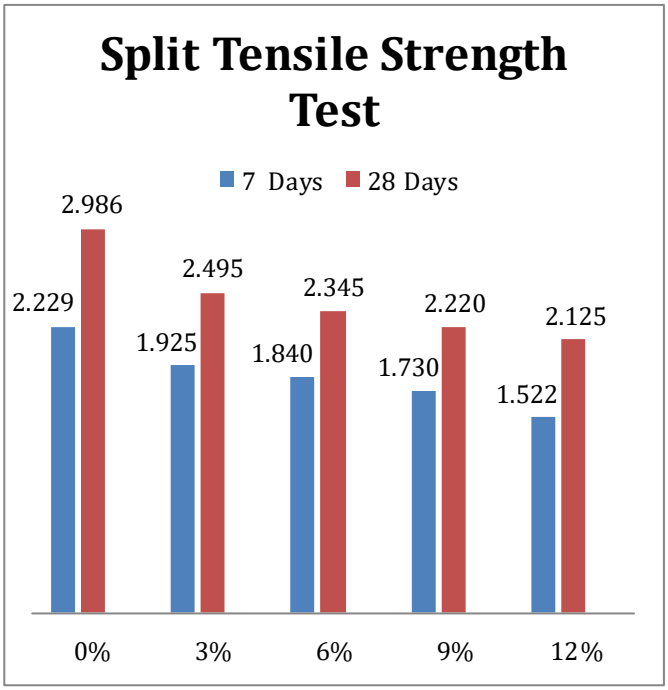
Compressive Strength Test:

Curing [Days]	7	28
Conventional concrete [N/mm²]	23.340	29.830
Mangalore Tiles 3% [N/mm²]	23.125	28.120
Mangalore Tiles 6% [N/mm²]	20.650	26.425
Mangalore Tiles 9% [N/mm²]	19.295	25.220
Mangalore Tiles 12% [N/mm²]	17.295	18.645



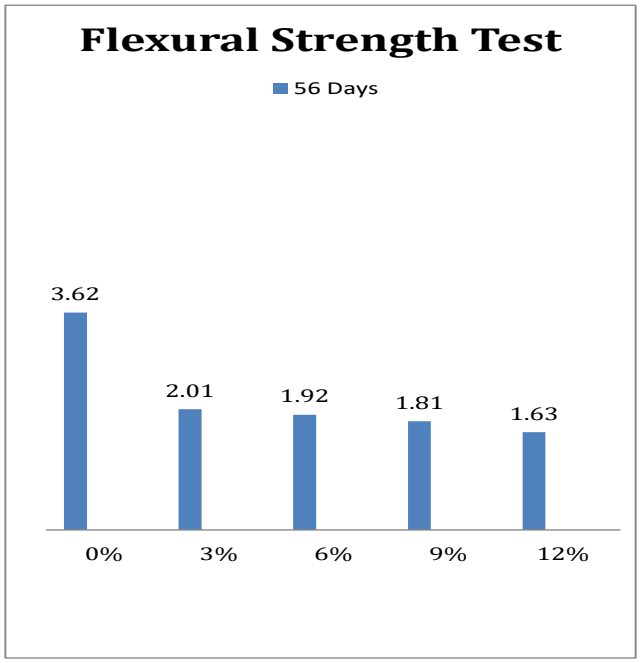
Split Tensile Strength Test :

Curing [Days]	7	28
Conventional concrete [N/mm²]	2.229	2.986
Mangalore Tiles 3% [N/mm²]	1.925	2.495
Mangalore Tiles 6% [N/mm²]	1.840	2.345
Mangalore Tiles 9% [N/mm²]	1.730	2.220
Mangalore Tiles 12% [N/mm²]	1.522	2.125



Flexural strength test:

Curing [Days]	56
Conventional concrete [N/mm²]	3.62
Mangalore Tiles 3% [N/mm²]	2.01
Mangalore Tiles 6% [N/mm²]	1.92
Mangalore Tiles 9% [N/mm²]	1.81
Mangalore Tiles 12% [N/mm²]	1.63



7. CONCLUSION

- The results obtained from basic material testing are within the limits and satisfactory.
- By observing the above results we can conclude that we can recommended the partially replacement of fly ash to cement and mangalore tiles to fine and coarse aggregate upto 9% to obtain required compressive strength.
- The designed concrete nix [M25] showed higher water abosoption of nearly 10% , which is due to mangalore tiles as fine and coarse aggregate.
- Eco – friendly and Mass utilization of waste materials as possible in construction by using Mangalore tiles wastage for partial replacement of fine and coarse aggregate.

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