Utilization of Bone Aggregate And Mangalore Tiles Waste As A Partial Replacement To Natural Sand And Course Aggregate In Concrete

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Abstract- *Civil engineering is the field where a 2D plan on a paper is turned into a reality 3D structure. In order to satisfy the needs of increasing population, the industry is growing exponentially. At the same time the growth has comprised the life sustaining environment around us, which has also lead us in scarcity of constant materials causing the increase in cost of these materials. This eventually may slowdown the constant industry which will affect the livelihood of people depending on it. In order to tackle this problem we either need to increase production of these materials which is not only eco-friendly but also cost efficient. In this project, an attempt was made to study the performance of concrete with partial replacement of fine aggregate with bone aggregate and coarse aggregate with Mangalore tiles waste. Initially 10% of Mangalore tiles waste was kept constant for coarse aggregate and bone aggregate was varied from 4% to 14% with even number of intervals in M20 mix. After performing compression test on casted cubes, highest strength was obtained for the cube which was replaced by 4% of bone aggregate. Keeping 4% bone aggregate constant, Mangalore tiles waste percentage was varied again by 4% to 14% with even number of intervals. Then compression test was performed on casted and cured cubes and maximum strength was obtained at 8% replacement of coarse aggregate by Mangalore tiles waste.*

Keywords- Bone aggregate, Mangalore tiles aggregate, alternative building material, low cost and efficient concrete, eco-friendly.

I. INTRODUCTION

In today's world construction has increased rapidly as a reason of which concrete has become very important material. Irrespective of construction, concrete is used in every project. As a reason of which concrete has become second most consumable product after water. Along with this increased demand of concrete, it adds on to another two important which forms a major part of concrete fine and coarse aggregate. This report is the outcome as an attempt to reduce the impact on the environment due to construction industry and also to reduce the problem of dumping the wastes. The report also tries to change the outlook of contractors to the conventional materials used in the industry and bring to their notice about the suitable alternatives like Mangalore tiles waste and Bone aggregates for coarse and fine aggregates.

There used to be a number of industries that produced clay tile in Dakshina Kannada district located in the coastal region of Arabian Sea. According to a survey there were about 75 such factories in Dakshina Kannada in the year 1994 when such tiles were in great demand. But today there is not as much demand for tiled roof structures as RCC buildings have become a trend in the industry. Recently, the number of such factories have reduced to 12. These industries are trying to make their ends meet as the demand for these tiles have dropped to a huge extent. Inspite of that, the tiles are still being used and a certain quantity of such material ends up as a construction waste. In India, especially Mangalore, there is no efficient method of disposal of these waste tiles. So, methods for reducing wasted tiles must be employed and this calls for its usage in concrete.

Bone is a hard, strong, fibrous material in mammalian body which gives strength and shape to the body. The bones used for this project are obtained from animals, which were slaughtered away and then all the flesh from the bone structure were removed. Some bones may also be obtained from dead and decayed animals leaving only the bones. The history has shown us that the bone does not decay easily and thus they last for a long time.

The bone aggregates used for the project are obtained by heating the animal bones in high temperature and then pulverizing it to the required gradation.

II. LITERATURE REVIEW

Aruna D et.al (2015)[1]: Based on the studies conducted it was found that Mangalore tiles waste can be used

as partial replacement to coarse aggregate in normal concrete. Also it is helpful in reducing environmental problem such as waste disposal. He concluded that T25 (i.e., 25% replacement of coarse aggregate with tiles waste) design mix is recommendable for tile based concrete. About 10-15% decrease in strength was observed. However these waste tiles could be used as fillers and is beneficial in handling and management. Compressive strength of concrete with partial replacement of coarse aggregate by clay tile decreases as the percentage of replacement increases. Strength reduction is of order 10%, 17 % and 46 % corresponding to P10, P20 and P30 mix, where P10 represents mix with 10% replacement, P20 represent 20% replacement and P30 represent 30% replacement respectively. It is said that the replacement of coarse aggregate by clay tile up to 20% is recommendable.

Kotresh K.M. et.al (2015)[4]:This experimental study was conducted in order to obtain a cost effective and eco-friendly concrete, by replacing natural sand and course aggregate with that of Ferrous slag and Mangalore tiles waste respectively. As a result low to medium strength concrete was obtained. The strength parameter of M15 and M20 concretes using Mangalore tiles were comparable to that of M10 and M15 conventional concrete, but the former one is economically cheaper by about 20%. The study revealed that the mix designs failed to achieve target strength in both m20 and M15 mix; thus providing a low to medium strength concrete.

A.A. Adekunle.et.al (2016)[6]: This research has looked into the use of agro waste in the construction industry, especially in the partial replacement of cement in the concrete. Cement was partially replaced at 5,10,15,20 and 25% with bone ash and wood ash separately. Chemical analysis was also carried out on both the replacement materials to determine their pozzolanic properties. As a result it was found that the bone ash is a better pozzolana when compared to the wood ash. The compressive test results proved that wood ash is not a good material for replacing cement in concrete, while 10% of bone ash can partially replace cement in concrete at 28 days of curing.

Amaziah Walter Otunyo (2014)[8]: A study on the suitability of machine crushed cow bones (MCCB) as partial replacement for natural sand in concrete was carried out. They have opted the mix proportion of 1:2:4 for this experiment, by replacing 0%,25%,50%, 65%,75%, and 100% of sand using MCCB. The values of the compressive strength at 28days for replacement range of 25% to 50% fine aggregate by MCCB corresponds to values of compressive strength for lightweight concrete (17.6 N/mm2 -16.5 N/mm2). Also the aggregate crushing value of MCCB was found to be 32%. It was found that MCCB in concrete reduces the workability of concrete and also as a retarder.

III. OBJECTIVES

The main objectives of this project are:

- To prepare a mix using Mangalore tiles waste and bone aggregate using different percentage of replacement of coarse aggregate and fine aggregate in production of conventional concrete.
- To obtain engineering properties of fresh and hardened concrete mixture prepared as per IS code.
- To study the optimum percentage of Mangalore tiles waste which will replace the same amount of coarse aggregate.
- To study the optimum percentage of bone aggregate which will replace the same amount of fine aggregate.
- To study the strength parameters of replaced concrete prepared.
- To use the results from the study that replacing both coarse aggregate and fine aggregate to a certain extent will not only reduce the negative impact on the environment but also economical.
- To obtain a light weight concrete.

IV. MATERIALS USED

CEMENT

Cement is a building material used for binding the aggregates. It is used in construction which sets and hardens and eventually helps in binding the material such as coarse aggregate, fine aggregate and water. The materials used in the manufacture of cement consist mainly of lime, clay, Bauxite and laterite. First they are taken in proper proportions, crushed and grind to fine powder. After that the resulting mass is heated for about 14000C to 1500oC in kiln, where lime, alumina and silica are combined together to form a mixture of calcium silicates and calcium aluminates. This is called as a clinker. Then the clinker is properly ground and about 3 to 4% of gypsum is added to the mixture, after this the fine powder is collected which is called cement. In our experimental work ACC cement of 43 grade was used.

FINE AGGREGATE

IS 383-1963 defines fine aggregate as the aggregates most of which will pass through 4.75 mm IS sieve. The fine aggregate is often termed as sand size aggregates. Sand is generally considered to have a lower size limit of 0.07mm.In

this project, river sand which is locally available is used. It is most commonly preferred in production of concrete. Sea sand is not used due to presence of minerals like calcium and chloride which leads to efflorescence. River sand is obtained from river banks and is off white in colour and sand used in concrete should be free from impurities like organic matter, dirt, pebbles, humus, and crushed shells to prevent the deterioration and creation of voids with passage of time.

BONE AGGREGATE

The animal bones can be obtained from dead animals, be it be buffalos, cows, goats or any other animals. Once the meat is separated from the bones for consumption purpose, the bare bones are usually thrown away, where they are randomly disposed and thus imposing severe environmental problems.

Bone aggregate is produced from heated bones which contains calcium, phosphate and hydroxyl ions and small amount of cationic magnesium and strontium replacing calcium and bicarbonate, and fluoride replacing the hydroxyl anions.

The bone aggregate used for this project were collected and dried after they had been completely separated from the flesh, tissues and fats. Then these bones were heated and dried properly. The dried bones were then pulverized using a crusher and then it is stored in bags. We have used bone aggregate which was readily available in fertilizer shop and was processed using above mentioned method.

COARSE AGGREGATE

The Coarse aggregate is defined as an aggregate most of which is retained on 4.75mm IS sieve. The aggregates are formed due to the natural disintegration of rocks or by artificial crushing of rock or gravel. Metro graphic description, specific gravity, hardness, strength, physical and chemical stability, pore structure and colour - these are the properties and mineral composition of aggregate. The coarse aggregate helps in providing bulk to the concrete and to increase the density of concrete. In this project 20mm down size, cubical and angular aggregate are used, it provides better bonding and inter locking property to concrete.

MANGALORE TILES

Mangalore tile is a construction material which is used commonly in Mangalore city and hence the name emerged as Mangalore tiles. Because of the hard laterite clay is used as raw material to produce red tile, and the production of laterite clay is more in the Mangalore city. It was first introduced by German missionary in 1860.Since then tile industry has flourished in India. Conventional size of tile is 10x16 inches, but they are also available in different sizes as per requirement. These days glazed Mangalore tiles are available and they provide a better appearance then the conventional red tiles. Mangalore tiles are eco-friendly, durable, cheap and costs less than the coarse aggregate. It can be used in heavy rainfall regions, red colour of Mangalore tile is mainly because of high iron content. In our project partially replacing the coarse aggregate by Mangalore tile waste. The replacing ratio is 10%, the strength of concrete decrease with increase in replacement ratio.

POTABLE WATER

Water is the most important and least expensive ingredient of concrete. Without which concrete will not be able to set. Water reacts chemically with cement to form the binding matrix in which inert aggregate are held in suspension until the matrix has hardened. Water serves as a lubricant between the fine and the coarse aggregate so that concrete can be placed easily.

Water used for concrete mix should be clean, free from all sort of impurities like organic materials, alkalis, oil, dust particles and any other kind of deleterious materials. If impurities is more in water, it affects the setting time of cement, strength of concrete and may result in corrosion. Water which is fit for drinking is acceptable for making concrete. Sea water cannot be used in concrete because it

contains high amount of chlorides and sulphates which will result in dampness, efflorescence etc. In this project the good quality of potable water is used for making concrete.

V. METHODOLOGY

- Initial tests were conducted for all the materials and nominal mix of M20 grade concrete was opted for our experimental project.
- Initially with the control concrete, 4%, 6%, 8%, 10%, 12% and 14% of the fine aggregate was replaced by bone aggregate and 10% of Mangalore tiles waste with coarse aggregate; then the data from the concrete containing bone aggregate was compared with the data from standard concrete.
- Four cube samples were cast on the mould of size 150*150*150 mm for each 1:1.5:3 concrete mix with partial replacement of fine aggregate with a W/C ratio of 0.48.
- After about 24 hours, the specimens were de-moulded and water curing was continued till the respective specimens were reached 7 and 28 days and tested for compressive strength and water absorption tests.
- Total of 28 cubes were casted in the first batch and was tested successfully.
- The percentage replacement of fine aggregate which resulted in highest compressive strength was selected and second set of cubes were casted by varying the coarse aggregate replacement by 4%, 6%, 8%, 10%, 12% and 14%.

VI. INITIAL TESTS CONDUCTED

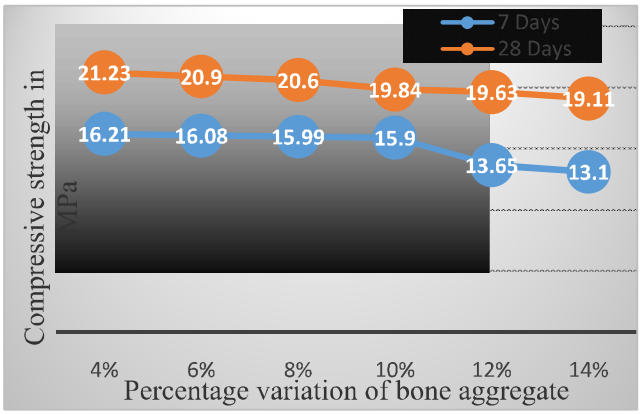
Cement

Sand

Coarse aggregate
Bone aggregate
Mangalore tiles waste

VII. RESULTS AND DISCUSSION

SL. NO	REPLACEMENT PERCENTAGE	7 DAYS	28 DAYS
1	0% BONE AGGREGATE +0% MANGALORE TILES WASTE	16.46	21.58
2	4% BONE AGGREGATE +10% MANGALORE TILES WASTE	16.21	21.23
3	6% BONE AGGREGATE +10% MANGALORE TILES WASTE	16.08	20.90
4	8% BONE AGGREGATE +10% MANGALORE TILES WASTE	15.99	20.60
5	10% BONE AGGREGATE +10% MANGALORE TILES WASTE	15.90	19.84
6	12% BONE AGGREGATE +10% MANGALORE TILES WASTE	13.65	19.63
7	14% BONE AGGREGATE +10% MANGALORE TILES WASTE	13.10	19.11



Graph 1: Comparison of compressive strength using different percentage of bone aggregate (10% of Mangalore tiles aggregate is kept constant throughout)

VIII. COST ANALYSIS

For 1 m3 of sand and coarse aggregate, the approximate cost is 900Rs each. The cost of bone aggregate and Mangalore tiles waste is assumed to be 100 Rs/m3, which just includes the transportation and crushing cost.

C.T.	Consumption of material for M20 concrete (kg)					Total cost/m³ Of concrete	% of cost difference
	Cement	Sand	Bone aggregate	Coarse aggregate	Mangalore tiles waste		
C0	403.2	672	-	1326	-	4110	0
C4	403.2	6451	26.88	1219.92	106.08	4048	1.5
C6	403.2	6316	40.32	1219.92	106.08	4037	1.8
C8	403.2	6182	53.76	1219.92	106.08	4026	2.04
C10	403.2	6048	67.20	1219.92	106.08	4016	2.3
C12	403.2	5913	80.64	1219.92	106.08	4005	2.6
C14	403.2	5779	94.08	1219.92	106.08	3990	3

IX. CONCLUSION

From the results of this experimental study, it is possible to conclude that Mangalore tiles can be used as replacement to coarse aggregate and bone aggregate as replacement to fine aggregate. The rate of absorption of water is higher in both bone aggregate as well as Mangalore tiles. And density of bone aggregate and Mangalore tiles waste is less compared to conventional concrete. The use of Mangalore tiles waste and bone aggregate as partial replacement for coarse aggregate and sand respectively, in concrete mix resulted in decrease in strength compared to that of normal concrete.

The maximum strength is obtained when 8% of coarse aggregate is replaced by Mangalore tiles waste and 4% of natural sand is replaced by bone aggregate.By using Mangalore tiles and bone aggregate for replacement them, we can minimize the problem of disposal.Though the strength is comparatively lesser than that of control mix, it can be used for minor construction works so as to reduce the overall cost.

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