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Experimental Investigation on Composite Concrete Beams by Using Tiles/Marbles Residue

S.Vijayalakshmi ,D.Sriruban

***Abstract*—** Nowadays the replacement of alternate materials with the conventional ingredients of concrete plays a major role in the infrastructure projects across the globe.The replacement of cement in concrete with sufficient strength became mandatory to reduce the cost of construction. The present investigation deals with the partial replacement of tile dust with the cement in the conventional concrete mixture. Initially, the test specimens are made by partially replacing cement in concrete by tile dust as 0%, 10%, 20%, 30%, 40% & 50%. Then, the laboratory tests are conducted for the development of compressive strength, split tensile strength and flexural strength of concrete at the age of 7, 28, 56 days. These results are compared with the conventional concrete mixture of same proportions.

Keywords- ceramic waste,naturalproducts,tile dust.

I. INTRODUCTION

Concrete is one of the most widely used construction materials in the world. The production of Portland cement as the essential constituent of concrete requires a considerable energy level and also releases a significant amount of chemical **carbon dioxide emissions and other greenhouse gases** (GHGs) into the Atmosphere. Thus, seeking an eco-efficient and sustainable concrete may be one of the main roles that construction industry should play in sustainable construction. The problem of waste accumulation existsworldwide,specifically in the densely populated areas. Mostof these materials are left as stockpiles, landfill material orillegally dumped in selected areas [1]. In fact, concrete is theworld's most consumed man made material and its use isexpected to increase substantially. However, the production ofconcrete is not environmentally friendly and thereforesignificant environmental advantages may be realized ifalternate, environmentally sensitive materials are identified foruse in concrete [2].During the last few decades society has become aware ofthe deposit problems connected with residual products, anddemands, restrictions and taxes have been imposed. And as itis known that several residual products have properties suited.for concrete production, there is a large potential in investigating their possible use in concrete products manufacturing. Well-known residual products such as silica fume, fly ash, sediments, etc. may be mentioned [3]-[5].

S.Vijayalakshmi,PG Scholar , M.E Structural Engineering, Department of Civil Engineering Gnanamani college of Engineering, Namakkal, Tamil nadu, INDIA

Mr.D.Sriruban, Assistant .Professor, Department of Civil Engineering , Gnanamani college of Engineering, Namakkal, Tamil nadu, INDIA

The three basic directions of producing environmentally friendly concrete are, increasing the use of conventional products and minimizing the clinker content, developing new green cements and binding materials. Concrete with inorganic residual products [4].Cement, which is an integral part of all standard concreteproducts, is the most significant and harmful factor andenvironmental burden when producing concrete or concreteproducts. Replacing energy consuming Portland cement withrecyclable materials and minerals offers two distinct benefitsto the environment - it significantly reduces the amount ofCO_2 released into the atmosphere and it minimizes massivelandfill disposal [6], [7]. In contemporary concrete productionsuccessful reduction of cement is usually done by replacing apart of the required cement content with fly ash [8], [9], silicafume and others wastes with pozzolanic properties [10], [11].

The aim of this work is to make the feasibility study of usage of the tiles reside as a partial replacement for cement in concrete, which is a waste material. For this purpose the various composition of tile dust were chosen and they are compared with the concrete of same mix propositions.

II. EXPERIMENTAL MATERIALS

A. Cement

Ordinary Portland cement (OPC) is by far the most important type of cement. All the discussions that we have done in the previous chapter and most of the discussions that are going to be done in the coming chapters relate to OPC. Prior to 1987, there was only one grade of OPC which was governed by IS 269-1976. After 1987 higher grade cements were introduced in India.

The OPC was classified into three grades, namely 33 grade, 43 grade and 53 grade depending upon the strength of the cement at 28 days when tested as per IS 4031-1988. If the 28 days strength is not less than 33N/mm2, it is called 33grade cement, if the strength is not less than 43N/mm2, it is called 43grade cement, and if the strength is not less than 53 N/mm2, it is called 53grade cement. But the actual strength obtained by these cements at the factory is much higher than the BIS specifications.

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TABLE-I

PROPERTY	IS: 8112-1989 CODE
Specific Gravity	3.12
Consistency	33
Initial setting time	30 minimum
Final setting time	601 maximum

Physical properties of (OPC) Cement

B. Aggregate

Aggregate gives body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is a good gradation of aggregates. Good grading implies that a sample fraction of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, higher strength, lower shrinkage and greater durability.

C. Tiles residue

The principle waste coming into the ceramic industry is the ceramic powder(tiles powder), specifically in the powder forms. Tiles wastes are generated as a waste during the process of dressing and polishing. It is estimated that 15 to 30% waste are produced of total raw material used, and although a portion of this waste may be utilized on-site, such as for excavation pit refill, The disposals of these waste materials acquire large land areas and remain scattered all around, spoiling the aesthetic of the entire region. It is very difficult to find a use of ceramic waste produced.

Ceramic waste can be used in concrete to improve its strength and other durability factors. Ceramic waste can be used as a partial replacement of cement to achieve different properties of concrete.

Fig.1 Tiles residue powder

D. Marbles residue

In building industry, Marble has been commonly used for various purposes like flooring, cladding etc., as a building material since the ancient times. The industry's disposal of the marble dust material, consisting of very fine powder, today constitutes one of the environmental problems around the world. In India, marble dust is settled by sedimentation and then dumped away which results inenvironmental pollution, in addition to forming dust insummer and threatening both agriculture and public healthand also the marble processing is one of the most thriving industry the effects.

Fig. 2 Marbles residue powder

E. Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

III. PREPARATION OF SPECIMEN

A. Mix Proportioning For Tiles Residue

The Mix proportion used this investigation was 1:1.4:3.1/0.5. The WGA is replaced by 10%,20%,30%,40% and 50% volume.

TABLE II
Mix proportion for tiles residue

SAMPLE	% OF CEMENT	% OF WASTAGE
A0	100	0
A1	90	10
A2	80	20
A3	70	30
A4	60	40
A5	50	50

A0,A1,A2,A3,A4 and A5 denote the mixtures of replacement of fine aggregate.

B. Preparation of test specimen for tiles residue

The total number of concrete specimen cast for conducting the different tests are listed below in Table III.

TABLE III
Specimen Detail for tiles residue

Sl.no	Name of the test	Specimen	% of tiles residue added	No. of specimen	
				7 days	28 days
1	Compressive strength test	Cube 150mmx150 mmx150mm	0% 10% 20% 30% 40% 50%	3 3 3 3 3 3	3 3 3 3 3 3
2	Split Tensile Strength test	Cylinder 150mm diameter 300mm height	0% 10% 20% 30% 40% 50%	3 3 3 3 3 3	3 3 3 3 3 3

C. Mix Proportioning For Marbles Residue

The Mix proportion used this investigation was 1:1.4:3.1/0.5. The WGA is replaced by 5%, 10%, 15%, 20% and 25% volume.

TABLE IV
Mix proportion for marbles residue

Sample	% Of Cement	% Of Wastage
A0	100	0
A1	95	5
A2	90	10
A3	85	15
A4	80	20
A5	75	25

A0, A1, A2, A3, A4 and A5 denote the mixtures of replacement of fine aggregate.

D. Preparation of test specimen for marbles residue

The total number of concrete specimen cast for conducting the different tests are listed below in TABLE V

TABLE V
Specimen Detail for marbles residue

Sl.no	Name of the test	Specimen	% of marbles residue added	No. of specimen	
				7 days	28 days
1	Compressive strength test	Cube 150mmx150mmx 150mm	0% 5% 10% 15% 20% 25%	3 3 3 3 3 3	3 3 3 3 3 3
				7 days	28 days
2	Split Tensile Strength test	Cylinder 150mm Diameter 300mm height	0% 5% 10% 15% 20% 25%	3 3 3 3 3 3	3 3 3 3 3 3

E. Mixing

The mix design is produced for maximum size of aggregate is 20mm conventional aggregate. The variation of strength of hardened concrete using tile dust as partial replacement for cement is studied by casting cubes and cylinders until 50% and 20%. The concrete was prepared in the laboratory using mixer. The cement, fine aggregate and coarse then the desired quantity of water and admixture is added and the whole concrete is mixed for five minutes, the concrete is poured in the moulds which are screwed tightly. The concrete is poured into the moulds in three layers by tamping with tamping rod for cubes of 150x150x150 mm size and cylinders of 150mm diameter 300mm height tested for compression and split tensile strengths. The casted specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7, 28, days the specimens are removed and these are tested for compression and split and the results are compared with conventional concrete.

F. Casting

Bureau of Indian Standards has recommended step by step procedure for mixdesign. Here the mix design procedure given in IS: 10262:2009 is adopted. The variation of strength of hardened concrete using tile dust as partial replacement of cement is studied by casting 3 cubes, 3 cylinders and 3 beams for each and every replacement. The specimens were tested for compression, split tensile and flexural strengths after curing period of 7days, 28 days and 56 days.As per the mix design, the quantities required for casting 9 cubes, 9 cylinders, 9 beams for each percentage replacement are computed.

IV. TESTS CONDUCTED

The following tests are conducted for the above mentioned mixtures.

A. Standard Consistency Test
B. Specific gravity test
C. Slump test
D. Vee bee consistometertest
E. Hardened concrete test
F. Compressive strength tests
G. Split tensile strength test

The above mentioned tests are conducted on the prepared specimens.

V. RESULTS AND DISCUSSION

From the obtained results the following graphs are plotted.

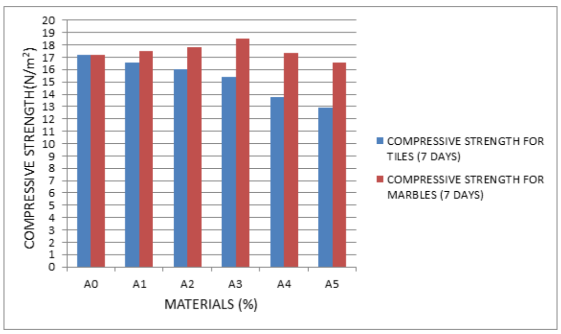

Fig.3 Comparison Of Compressive Strength Between Tiles And Marbles (7 Days)

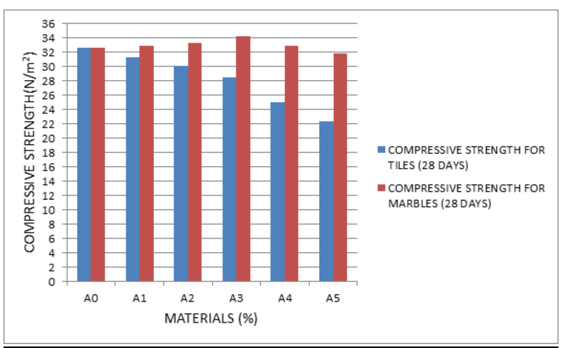

Fig 4 Comparison Of Compressive Strength Between Tiles And Marbles (28 Days)

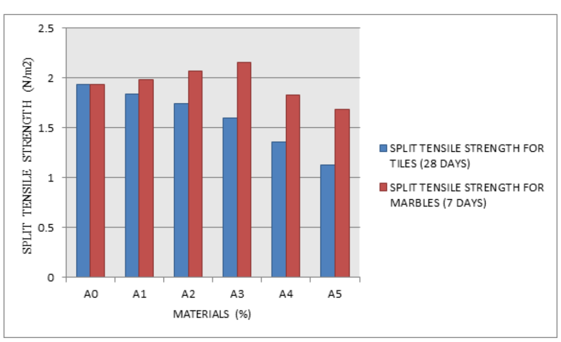

Fig.5 Comparison Of Split Tensile Strength Between Tiles And Marble (7 Days)

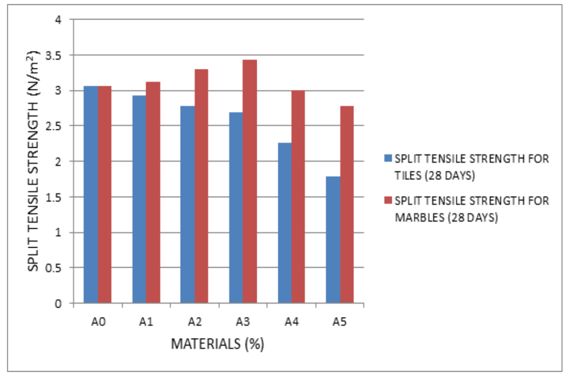

Fig. 6 Comparison Of Split Tensile Strength Between Tiles And Marble(28 Days)

VI. CONCLUSION

The following conclusions are obtained on performing the experiments

- Concrete with tiles dust as partial replacement for cement has minor strength loss which can be negligible.
- There is not much remarkable decrease in strength of concrete up to 30% replacement. Further replacement of cement with tile dust decreases the compressive strength. Up to 30% replacement of cement with tiles dust in concrete is technically and economically feasible and viable.
- It is the possible alternative solution of safe disposal of Ceramic waste. By adopting such methods we can overcome problems such as waste disposal crisis.
- For 20% cement replacement with tile dust indicates saving of around 17% in the cost of Portland cement in concrete. The cost of cement represents almost 45% of the concrete cost. Therefore, overall cost of the concrete will be reduced by more than 7.5%. Hence, the use of tile dust as partial replacement for cement in concrete is seems to be economical.
- The Compressive strength of Cubes and Split Tensile strength of Cylinders are increased with addition of waste marble powder up to 15% replace by weight of cement and further any addition of waste marble powder the compressive strength decreases.
- We have put forth a simple step to minimize the costs for construction with usage of marble powder which is freely or cheaply available; more importantly.
- We have also stepped into a realm of saving the environmental pollution by cement production; being our main objective as Civil Engineers.

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