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AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF COARSE AGGREGATE IN CONCRETE WITH CERAMIC WASTE

[1]N.Sharmili , PG Scholar, Structural Engineering, Bharathidasan Engineering College Nattrampalli.

[2]A.Sathiyamoorthy, Department Of Civil Engineering, Bharathidasan Engineering College Nattrampalli.

Abstract:

Natural sand is a standout among the most ordinarily utilized fine aggregate as a part of concrete. Owning to acute shortage of natural sand in many areas and keeping environmental and cost factors into consideration an alternative for the same is pondered. In view of above discussion, an attempt is made to replace the cement and coarse aggregate in concrete of M50 grade with fly ash and ceramic waste to study the workability and compressive strength at 7,14 and 28 days curing periods. According to the results of the experiment, it is concluded that with increase in replacement of fly ash, the maximum compressive strength was obtained in M2 mix at 28 days which was 6.93% more than M0. In final mixes maximum compressive strength was achieved in M2C1 which was 13.61% more than M0 mix. Also the unit weight of the specimen decreased by 8% for M2C1therefore it can be used for lightweight concrete.

Keywords- Natural Sand, Fine aggregates, Fly Ash, Ceramic Waste, Coarse aggregates.

1. INTRODUCTION

Concrete is a paste of cement, water and aggregates and in some cases rocks. Water and cement mixture coats the surface of the fine aggregates and the coarse aggregates. The paste gets starts gaining strength and gets hardens to form the rock- like mass known as concrete through a process called hydration. Fly ash remains, which is additionally termed as "pulverized fuel ash", is one of the waste buildup produced by coal ignition, and is made out of the fine particles that are driven out of the boiler alongside flue gasses. Ash that settles down the base of the boiler is termed bottom ash. In the creation of Portland cement concrete fly ash is utilized as a secondary cementitious material (SCM). A secondary cementitious material, utilized as a part of conjunction alongside portland cement, adds to the properties of the solidified concrete through hydraulic or pozzolanic action or both. A ceramic material may be defined as any inorganic crystalline material, compounded consists of metal and non-metal or metalloid atoms. Ceramic Materials are strong and inert. Ceramic materials are brittle, hard, and solid in pressure, frail in strain and additionally in shearing. They can withstand compound disintegration that happens in an acidic or scathing ‘environment. Ceramics generally can withstand very high temperatures that can go from 1,000 °C to 1,600 °C.

2. METHOD ANALYSIS

After proper mixing of ingredients, moulds of size 150mm×150mm×150mm were placed on vibrating machine after proper oiling and securely tighten to correct dimension. Proper care was taken that there is no gaps left from where there is any probability of leakage of concrete paste (slurry). Then the concrete is poured in the moulds in three layers. Each layer is left to vibrate for 8-12 seconds to avoid honey combing and moulds are filled up to the brim. After concreting and compaction upper surfaces made smooth with the help of trowel. The moulds were left undisturbed for 24 hours in the laboratory. A total of 81cubes were casted for the experimental study. All the specimens were casted according to IS 516:1959. Crushed stones of size greater than 4.75mm and passing through 20mm sieve conforming to IS 383:1970 were used in the study. Sieve analysis of coarse aggregates is given in Table3. The specific gravity of coarse aggregates is 2.63 and bulk density is 1.5. This leads to serious environmental and dust pollution and occupation of a vast area of land, especially after the powder dries up so it is necessary to dispose the Ceramic waste quickly and use in the construction industry.As the ceramic waste is piling up every day, there is a pressure on ceramic industries to find a solution for its disposal. The advancement of concrete technology can reduce the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment.

3. PROPOSED SYSTEM

The principle waste coming into the ceramic industry is the ceramic powder, specifically in the powder forms. Ceramic wastes are generated as a waste during the process of dressing and polishing.

Fig.1.Ceramic Powder

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. Aggregates are the important constituents in concrete. They give 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. 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.

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4. ANALYSIS

The evaluation of ceramic waste for use as a replacement of cement material begins with the concrete testing. Concrete contains cement, water, fineaggregate, coarse aggregate and grit. With the control concrete, i.e. 10%, 20%, 30%, 40%, and 50% of the cement is replaced with ceramic waste,the data from the ceramic waste is compared with data from a standard concrete without ceramic waste.

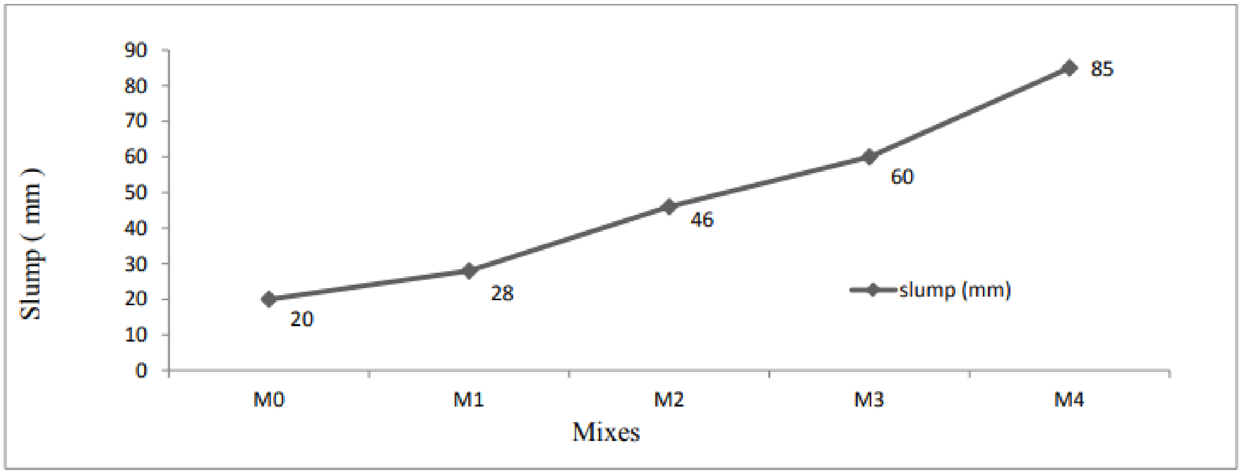

Fig.2. Analysis

Three cube samples were cast on the mould of size 150*150*150 mm for each 1:1.80:3.84 concrete mix with partial replacement of cement with a w/c ratio as 0.52 were also cast. After about 24 h the specimens were de-moulded and water curing was continued till the respective specimens were tested after 7, 14 and 28 days for compressive strength test. Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The loading rate on the cube is 35 N/mm2 per min.

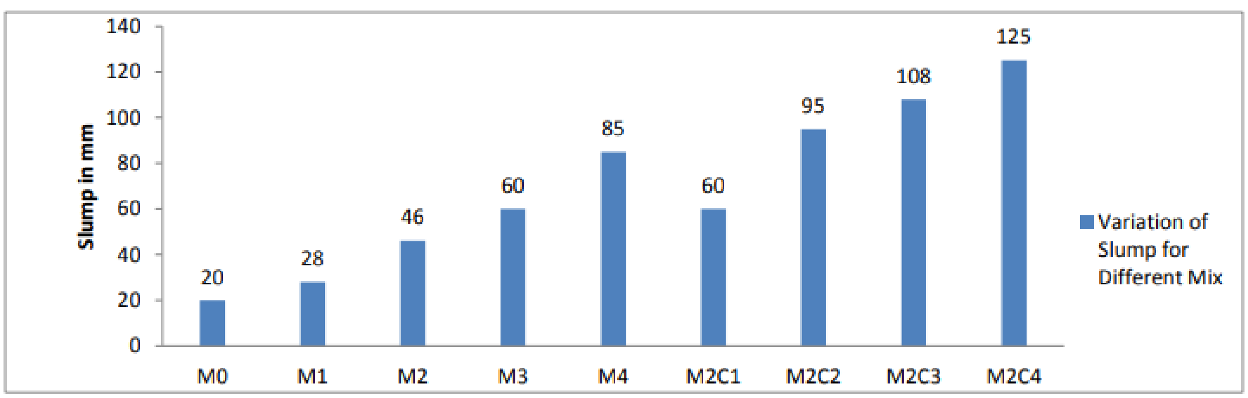

Fig.3.Value Mix

The comparative studies were made on their characteristics for concrete mix ratio of 1:1.80:3.84 with partial replacement of cement with Ceramic waste as 10%, 20%, 30%, 40% and 50%. Fresh property of concrete is determined by Workability of concrete which is one of the main physical parameter which affects the strength and durability as well appearance of the finished concrete and the cost of labor. Workability of concrete is measured with the help of slum test. .The slump flow of M0 was 20mm which is acceptable according to IS 4926:2003. The slump value goes on increasing from M0 to M4 as Fly ash imparts lateral strength as compared to cement which imparts early strength in concrete. According to IS code all the values are within the limiting range. The compression in slump values for initial mixes is shown in Fig.1.1. The slump flow goes on increasing from M2C1 to M2C2 and maximum slump was achieved in M2C4 i.e. 40% replacement of cement by Fly ash and 40% replacement of coarse aggregates by ceramic waste because angular and rough aggregates which results in poor workability are replaced by 40% by ceramic waste which are cubical in shape and smooth in surface.

After the completion of curing period of 7days, 14days and 28days cubes were tested for their compressive strength with the help of C.T.M, conforming to IS 516:1959. Cubes were tested immediately after removal from the curing tank. Cubes were placed on the platform of C.T.M. as shown in Figure 4.6 and the load was applied and gradually increased until the specimen is no more able to bear the load and graph shows a decreasing reading. The total load applied at the failure is noted down and this load divided by the area of the specimen gives the compressive strength of the specimen. Average of at least three specimen were taken for each day and results were recoded.

CONCLUSION

On the other hand compressive strength goes on increasing from M0 to M2C1 because the replacement of coarse aggregate was just only 10% and maximum ceramics were indulge in filling the voids present in the coarse aggregates which results in great bonding of materials and hence results in high compressive strength. The maximum compressive strength was attained in M2C1 composition which results in 5.8% decrease in weight per cube as compared to normal mix. The compressive strength was 13.61% more compared to M0, hence it can be used in light weight structures.

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