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STRENGTH AND DURABILITY OF TERNARY BLENDED CEMENT CONCRETE

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ABSTRACT

This project deals with partial replacement of cement by Natural Steatite Powder and Metakaolin, replacing Fine aggregate by Fly Ash and Waste powder derived from Building Demolition in cement concrete. Ultra Fine Natural Steatite powder and Metakaolin added in the proportion of 15% and 7% by mass of cement to control mix. Class F Fly Ash was added in the proportion of 20% by mass of Fine aggregate and Waste powder from building demolition added in the proportion of 30% by mass of natural sand to control mix. Tests were performed for properties of fresh concrete. Compressive strength was determined at 7 and 28 days curing, splitting tensile strength and flexural strength were determined at 28 days curing. Test results indicate significant improvement in the strength properties of plain concrete by the inclusion of Fly Ash as partial replacement of fine aggregate and Metakaolin as a partial replacement of cement. In compressive strength development all the mixes gives better results compare to control mix. The partial replacement of cement by Ultra Fine Natural steatite powder and Fine aggregate by waste powder from building demolition decrease the flexural strength and splitting tensile strength but these materials combined with Metakaolin or Fly ash mixes gives better results.

1. INTRODUCTION

Concrete is the one of most cement based construction material used in the construction industry. Concrete is a mixture of cement, sand, coarse aggregate and water in a specified ratio on which the strength of the concrete depends. Concrete is used increasingly for a range of structural application and standards in a number of countries are being revised due to increasing the strength of concrete and preserve their natural environment by the way of improving the material used in concrete. It needs Extensive consumption of natural sources, massive amount production of industrial wastes and environmental pollution require new solutions for a more sustainable development. Cement, concrete and other composites are the common construction materials in world. Every tone of cement production and sand dredging from river which considerably influences natural environment. The concrete contain huge amount of sand and cement.

The mineral steatite, commonly known as soapstone, is a metamorphic rock composed mainly of talc ($Mg_3Si_4O_{10}(OH)_2$) and many other minerals such as magnesite and silica. Steatite has been widely employed in the carving of elements in facades of Brazilian historical buildings and baroque churches since the 17th century. Those buildings are now part of the world heritage3. A special cement based mortar containing additions of fine powder waste from mineral extraction of steatite has been developed in Brazil, as a composite material for restoration of steatite elements .The steatite is mostly used in electro techniques. This is used in ceramics due to its high resistivity, very low dielectric loss factor, and good mechanical strength. In this experiment the waste powder from extraction of steatite is partially replaced by cement.

2. MATERIALS AND METHODOLOGY

In this chapter deals with the various materials used in this project, origin, physical and chemical properties, and behavior of the materials and also deals with methodology of the experiment. Metakaolin (MK) is a pozzolanic material. It is obtained by the calcinations of kaolinitic clay at a temperature ranging between 500 °C and 800 °C. Although it showed certain amount of pozzolanic property, they are not highly reactive. High reactive metakaolin is made by water processing to remove un reactive impurities to make 100% pozzolan. Such a product, white or cream in color, purified thermally activated is called high reactive Metakaolin.The raw material input in the manufacture of metakaolin ($Al_2Si_2O_7$) is kaolin.

Size of particle	4.43
Colour	White
Physical form	Powder
Specific gravity	2.5
Maximum grain size	1,0

Table 1. Physical Properties of Metakaolin

Figure 1. Waste Powder from Building Demolition

Steatite is a type of metamorphic rock, largely composed of talc ore, rich in magnesium. It is composed of hydrated magnesium silicate: $Mg_3Si_4O_{10}(OH)_2$. Steatite is the softest known mineral and listed as 1 on the Mohs hardness scale. Composed essentially mineral massive talc With less than 1.5% of CaO and $Fe_2O_3$and less than 4% of Al_2O_3.Steatite is designated to indicate a pure variety of compact and massive talc while the use of word soap stone is restricted to a impure variety of steatite containing 50% - 80% of talc**.**

Ordinary Portland (43 grade) cement was used. The cement was purchased from Mutamil Builders. Mineral Admixtures UFNSP and metakaolin obtained from Astraa Chemicals.Class F fly ash was usedit is obtained from Tuticurin Thermal Power Plant. Fine aggregate was natural sand having a 4.75 mm nominal size. The coarse aggregate was 20 mm nominal size gravel.

2.1 Casting of Specimens and Curing

100 mm cubes were cast for compressive strength (ASTM C 39), 150×300 mm cylinders for splitting tensile strength, 100 mm×100 mm×500 mm beams for flexural strength. All the specimens were prepared in accordance with IS: 1199.

After casting, specimens were covered with plastic sheets, and left in the casting room for 24 hours at a temperature. They were demolded after 24 hours, and were put into a water-curing room until the time of the test. Three specimens were cast for each of the properties for all test ages.

Fg.2. Casting and Testing of Specimens

Concrete is prepared as per mix design. The freshly prepared concrete is filled in a clean slump cone in three successive layers. 25 tamping is given for each layer properly before adding another layer. Excessive concrete is strike of with trowel from the top of the mould after final layer has been tamped. The cone is removed immediately by raising it slowly and carefully in the vertical direction. The settlement or subsidence (slump) (i.e. difference between the height of the slump mould and the highest point of the subsidized concrete cone.) in cone measured as soon as it comes to stop.

3. RESULTS AND DISCUSSION

The variation of slump values are shown in Table 4.1. From the slump test results obtained it is observed that as percentage replacement ofadmixtures leads to decrease the workability. Particularly replacement of cement by ultra fine natural steatite powder and sand by fly ash tends to a decrease in slump value. An attempt is made to achieve workable mix, by varying the super plasticizer dosage in the range of 0.3% to 0.7% since w/c is maintained constant. The decrease in slump values is mainly attributed to the cohesive and stiffer mix resulted with higher fly ash content.

The flexural strength test results are shown in table 4.2. The partial replacement of cement by metakaolin in 7% and fine aggregate by fly ash in 20% increased the flexural strength of 18% and 25% compare to control mix. The strength increment in metakaolin and fly replaced mixes due to large pozzolanic reaction and improved interfacial bond between paste and aggregates. The replacement of cement with natural steatite powder decreased the flexural strength of 10.8% compare to control mix. The partial replacement of cement by metakaolin in 7% and natural steatite powder in 15%leads to strength reduction of 5.83% in M3. In M2 the splitting tensile strength was reduced 23.62% . The strength reduction due to the tensile strength of ultra fine natural steatite powder is very low. Similarly In M8 The fly ash over come strength reduction due to partial replacement of cement by ultra fine natural steatite powder.

MIX NO	Superplasticizer (%) in weight of cement	Slump value in mm
C M	0	84
1	0	65
2	0	30
3	0	25
4	0.3	25
5	0.5	100
6	0.5	80
7	0.5	78
8	0.5	50
9	0.7	25

Table.2. Slump Value

4. CONCLUSION

Replacement of cement with Metakaolin and fine aggregate with Class F Fly Ash significantly enhanced the compressive strength, splitting tensile strength and flexural strength of concrete.At 7 days completion of curing compressive strength of concrete increased between 11.57% to 44.21%. Maximum compressive strength development achieved at 44.21% in partial replacement of fine aggregate by fly ash.At 28 days completion of curing compressive strength of concrete increased between 1.53% to 46.26%, splitting tensile strength of concrete increased between 5.21% to 47.85% and flexural strength of concrete increased between 6.66% to 8%.Maximum compressive strength, splitting tensile strength and flexural strength achieved atpartial replacement of fine aggregate by fly ash, and fly ash combined with other admixtures (cement by metakaolin or natural steatite powder and fine aggregate by waste powder from builing demolition).Replacement of cement with ultra fine natural steatite powder and fine aggregate with waste powder from building demolition decrease the flexural and splitting tensile strength but these materials combined with metakaolin and fly ash mixes decrease the strength reduction.

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