An Experimental Study on the Behaviour of Concrete by Partially Replacement of Fine Aggregate with Granite Powder and Cement with Alcofine

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Abstract- Environmental concerns caused by the extraction of raw materials and CO2 emissions in the production of Portland cement led to pressures to reduce the consumption of this constituent of concrete, combined with the need to increase its durability. The cement is the most costly and energy intensive component of concrete. The unit cost of concrete can be reduced as much as possible by partial replacement of cement with other waste pozzolanic materials. Certain materials of mineral origin are also added to concrete to enhance their strength and durability properties of concrete materials such as Granite Powder needles and other by product like Alccofine. Granite powder and alccofine can be used in a combination as supplementary cementitious material as partial replacement of cement and Fine aggregate.

1.INTRODUCTION

1.1 GENERAL

Concrete is the most widely used manmade construction material in the world. It is obtained by mixing cement materials, water and aggregates, and sometimes admixtures in required proportions. The mixture when placed in forms and allowed to cure hardens into a rock – like mass known as concrete. The hardening is caused by chemical reaction between water and cement and continues for a long time, and consequently the concrete grows stronger with age. Concrete is generally classified as a normal strength concrete, high strength concrete and ultra-high strength concrete etc. As per Indian standard a recommended method of mix design denotes the boundary of 30Mpa between Normal strength concrete and high strength concrete.

GRANITE POWDER

Granite powder if formed by igneous rock composed mostly of quartz, alkali feldspar and plagioclase. It forms magma with a high content of silica and alkali metal oxide that slowly solidifies underground. It is common in Earth's continental crust, where it is found in various kinds of igneous intrusions. Granites powder can be predominantly white, pink, or gray in color, depending on their mineralogy. Granitic rocks are classified according to the QAPF diagram for coarse grained plutonic rocks and are named according to the percentage of quartz, alkali feldspar (orthoclase, sanidine, or microcline) and plagioclase feldspar on the A-Q-P half of the diagram. True granite (according to modern petrologic convention) contains between 20% and 60% quartz by volume, with 35% to 90% of the total feldspar consisting of alkali feldspar. Granitic rocks poorer in quartz are classified as syenites or monzonites, while granitic rocks dominated by plagioclase are classified as granodiorites or tonalites. Granitic rocks with over 90% alkali feldspar are classified as alkali feldspar granites. Granitic rock with more than 60% quartz, which is uncommon, is classified simply as quartz-rich granitoid or, if composed almost entirely of quartz, as quartzolite.

True granites are further classified by the percentage of their total feldspar that is alkali feldspar. Granites whose feldspar is 65% to 90% alkali feldspar are syenogranites, while the feldspar in monzogranite is 35% to 65% alkali feldspar. A granite containing both

muscovite and biotite micas is called a binary or two-mica granite.

ALCCOFINE

Alccofine is manufactured in the controlled conditions with special equipment to produce optimized particle size distribution which is its unique property. Alccofine 1203 and Alccofine 1101 are two types with low calcium silicate and high calcium silicate respectively. The computed blain value based on PSD is approximately 12000cm2/gm and is truly ultra- fine. Due to its ultra-fineness of Alccofine 1203, it provides reduced water demand for a given workability, even up to 70% replacement level as per requirement. There are many byproducts which are generated from industries and factories, dumped openly which cause environmental problems and also spread diseases. These byproducts can be utilized in useful way to save the environment. These by-products or so-called waste materials are fly ash, silica fume, ground granulated blast furnace slag and alccofine which are being reused now a days in construction industries for soil stabilization or concrete production mainly by making few stabilized changes in these waste materials.

1.Alccofine Micro Materials are a range of products of Counto Microfine Products Pvt. Ltd (CMPPL) – a joint venture between ACL and the Goa-based, Alcon Group, launched in the year 2013.

The two products that have been launched are Alccofine 1203 (a supplementary cementitious material suitably replaces Silica fume used in high performance concrete); and Alccofine 1101 (a micro-fine cement based product used for injection grout in underground tunnels and soil stabilization etc)

2. It is a new-generation, ultrafine product whose basic raw material is slag of high glass content with high reactivity obtained through the process of controlled granulation.

3. The raw materials are composed primarily of low calcium silicates. The processing with other select ingredients results in controlled particle size distribution (PSD). Due to its unique chemistry and ultra-fine particle size, ALCCOFINE 1203 provides reduced water demand for a given workability and can also be used as a high range water reducer to improve compressive strength or as a super workability aid to improve flow.

2.LITERATURE REVIEW

T. Felixkala *et al.* [1] had obtained the test results that granite powder of marginal quantity as partial sand replacement has beneficial effect on the mechanical properties such as compressive strength, split tensile strength, modulus of elasticity. They also indicated that the values of both plastic and drying shrinkage of concrete in the granite powder concrete specimens were nominal than those of ordinary concrete specimens. They examine the possibility of using granite powder as replacement of sand and partial replacement of cement with fly ash, silica fume, slag and superplasticiser in concrete. The percentage of granite powder added by weight was 0, 25, 50, 75 and 100 as a replacement of sand used in concrete and cement was replaced with 7.5% silica fume, 10% fly ash, 10% slag and 1% superplasticiser. The effects of water ponding temperatures at 26℃ and 38℃ with 0.4 water- to-binder (w/b) ratios on mechanical properties, plastic and drying shrinkage strain of the concrete were studied and compared with natural fine aggregate concrete.

Kanmalai Williams Reported the results of an experimental study on the high-performance concrete made with granite powder as fine aggregate. The percentage of granite powder added by weight a range viz. 0, 25, 50, 75 and 100% as a replacement of sand used in concrete and cement was replaced with 7.5%Silica fume, 10% fly ash, 10% slag and 1% super plastiziser. The effects of curing temperature at 32 Sand 0.40 water-to-binder (w/b) ratio for 1, 7, 14, 28, 56 and 90 days on compressive strength, split tensile strength, modulus of elasticity, drying shrinkage and water penetration of concrete were studied. Their results indicated that the increase in the proportions of granite powder resulted in a decrease in the compressive strength of concrete. The highest compressive strength was achieved in samples containing 25% granite powder concrete, which was 47.35 kPa after 90 days. The overall test performance revealed that granite powder can be utilized as a partial replacement of natural sand in high performance concrete.

M. G. Shaikh (2011) has found that the mixes with the artificial sand with dust as fine aggregate gives consistently higher strength than the mixes with natural sand. The sharp edges of the particles in artificial sand provide better bond with the cement

than the rounded part of the natural sand. It was found that the weight loss of artificial sand block is considerably same with respect to natural sand blocks at 20, 40, and 60 and 90 days, immersed in sulphuric acid solution during the experimental period and maintains pH 4 across it. Both concrete made using artificial sand and natural sand are moderate to chloride permeability. In water absorption test we observed after 24 hours curing, the increase in weight of both natural sand and artificial sand blocks are less than 3% that means both concrete are low absorber hence concretes are good quality. The test result obtained from well planned and carefully performed experimental program encourage the full replacement of natural sand by artificial sand with dust considering the technical, environmental and commercial factor. R.

S. No	Characteristics	Values obtained
1	Standard Consistency Test	29%
2	Specific Gravity	3.15
3	Fineness Test	8%
4	Initial setting Time	40 min

MATERIAL PROPERTIES

ALCCOFINE

GRANITE POWDER

PROPERTIES OF MATERIAL

CEMENT

OPC 53 grade (Ultra tech) cement is used for all concrete mixes. The cement is used fresh and free from lumps. The various tests were conducted on the cement and the results obtained are reported in table.

S. No	Mix Proportions	7 Days Compressive Strength N/mm^2	14Days Compressive Strength N/mm^2	28Days Compressive Strength N/mm^2
1	5%	22.8	31.24	43.86
2	10%	31.58	33.45	46.96
3	15%	27.25	35.36	49.94
4	20%	21.94	32.62	45.39

CEMENT

ALCCOFINE

S. No	Characteristics	Values obtained
1	Average particle size	4-6 microns
2	Fineness	12000cm2/gm
3	Specific gravity	2.86
4	Bulk density	635kg/m3

GRANITE POWDER

S. No	Characteristics	Values obtained
1	POROSITY	VERY LOW
2	Specific Gravity	2.6
3	Density	2500 kg/m^3
4	Crushing strength	1500kg/m^2

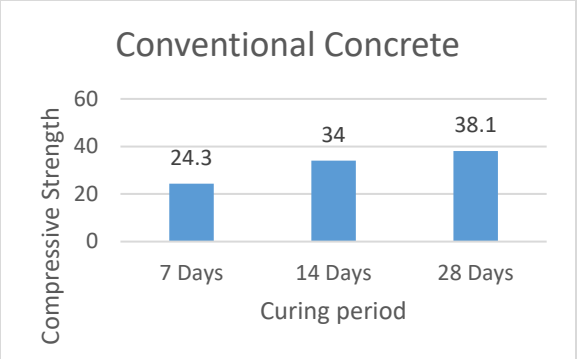
MIX PROPORTIONS

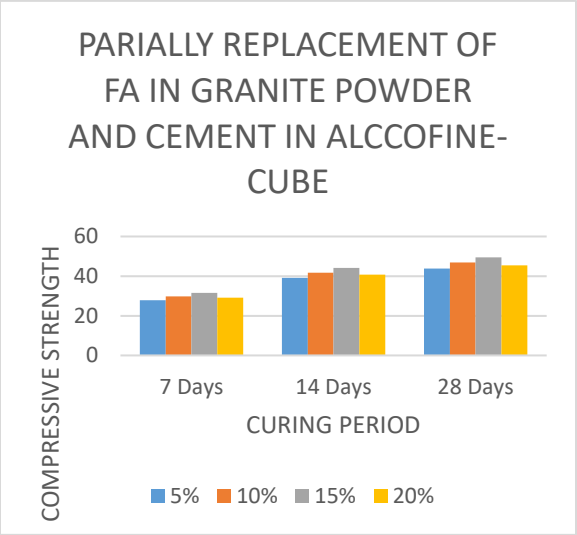
Grade of mix	Cement Kg/m^3	Fine Aggregate Kg/m^3	Coarse Aggregate Kg/m^3	Water Cement Ratio L/m^3
M_{30}	426 1	568 1.33	1087 2.55	191.5 0.44

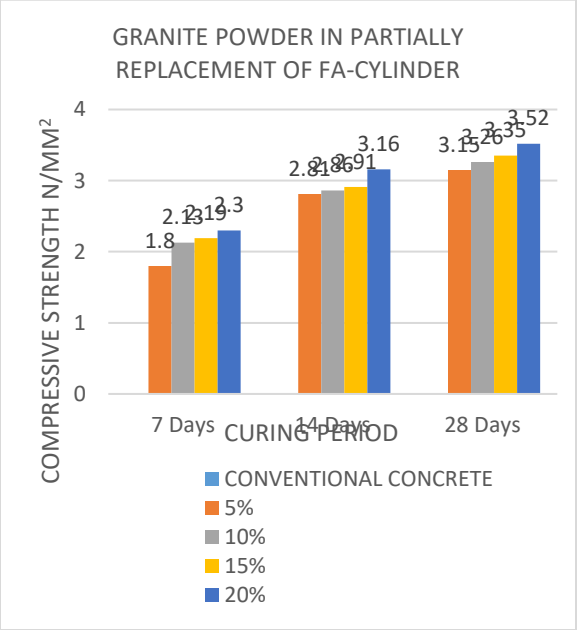
COMPRESSIVE STRENGTH (CUBE)

SPLIT TENSILE STRENGTH (CYLINDER)

The compressive strength of concrete at the age of 7, 14 & 28days. Cubes were casted in the size 150mm X 150mm X 150mm. The concrete was prepared in M30 Mixproportion.







SPLIT TENSILE STRENGTH

S. No	Mix Proportions	7 Days Compressive Strength N/mm²	14Days Compressive Strength N/mm²	28Days Compressive Strength N/mm²
1	5%	2.21	3.1	2.41
2	10%	2.36	3.03	3.38
3	15%	2.5	3.24	3.63
4	20%	2.15	2.81	3.32

15% alccofine with 15% Granite powder gives increase in Tensile strength which is 7.11% in 28 Days.

CONCLUSION

Granite powder and alccofine can be used in a combination of supplementary cementitious material as partial replacement of cement and Fine aggregate

CUBE

15% alccofine and 15% Granite powder gives 49.44Kn/m2 in COMPRESSIVE STRENGTH, which is 29.76% increase in comparison with conventional concrete of M30 grade which is optimum amongst combinations in 28 Days.

CYLINDER

- 15% alccofine and 15% Granite powder gives 40.55N/mm2 in COMPRESSIVE STRENGTH which is 30.46% increase in comparison with conventional concrete of M30 grade which is optimum amongst other combinations with in 28 Days.
- 15% alccofine and 15% Granite powder gives 3.31N/mm2 increase in SPLIT TENSILE STRENGTH which is 7.11% increase in comparison with conventional concrete of M30 grade which is optimum amongst other combinations within 28 Days.

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