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COMPARATIVE STUDY OF OPC AND PSC WITH PARTIAL REPLACEMENT OF DIFFERENT POZZULOIC MATERIALS

K.ASWINI[1]
P.G STUDENT KMMITS TIRUPATI

ABSTRACT: *In the present investigation an attempt is made to compare various compressive strengths of cement mortar cubes. Mathematical models were elaborated to predict the strength of mortar cubes with 10% partial replacement of cement by various types of mineral admixtures with and without super plasticizers. The strength of cubes with different types of cement (OPC, PSC) after 3,7,28 and 90 days with 28 days curing and also durability tests after 60 days, have been analysed to evaluate the effect of addition content, the time of curing and the type of cement on the changes in compressive strength. The test results of selected properties of binders and hardened mortar cubes with admixtures are also included. The analysis showed that mortar cubes with admixtures is characterized by advantageous applicable qualities.The investigation revealed that use of waste materials like fly ash, micro silica, rice husk ash and ground granulated blast furnace slag, which are otherwise hazardous to the environment may be used as a partial replacement of cement, leading to economy and in addition by utilizing the industrial wastes in a useful manner the environmental pollution is also reduced to a great extent.*

KEY WORDS : cement , fly ash , compression strength ,super plasticizers etc..

1.1. GENERAL

The greatest challenge before the construction industry is to serve the two pressing needs of human society namely the protection of the environment and meeting the infrastructure requirement of our growing population and consequentially needs of industrialization and urbanization in the past. The concrete industry has met these needs very well. However for a variety of reasons, the situation has been changed now.

The cement and concrete industries due to their large size are unquestionably feasible scope for economic and safe disposal of millions of tonnes of industrial by products such as fly ash, microsilica, slag, rice husk ash. Due to their properties, byproducts can be used in certain amount such as cement replacement material than in the practice today. In fact, these mixes replaced by 15% of by-products have shown high strength and durability at relatively early ages. This development has removed one of the strong objections to the use of high volume of by products in mortar cubes.

Therefore, it should be obvious that certain scale cement replacement with industrial by products is highly advantageous from the stand point of cost, economy, energy efficiency, durability and overall ecological and environmental benefits.

The advantageous in concrete technology method of construction and type of construction have paved the way to make the best use of locally available materials by judicious mix proportioning and proper workmanship so as to result in a construction industry satisfying the performance requirements. Proper design of mixes is intended to obtain such proportioning of ingredients that will produce of high durability during the designed life of a structure.

High performance does not necessarily require high strength, it is proportioning of mixes, which has low

permeability, as possible for particular use that determines the long-term high strength performance behaviour of a structure.

1.2. ADMIXTURES

Admixtures are materials other than cement, aggregate and water that are added to concrete either before or during its mixing to alter its properties, such as workability, curing temperature range, set time or color. Some admixtures have been in use for a very long time, such as calcium chloride to provide a cold-weather setting concrete. Others are more recent and represent an area of expanding possibilities for increased performance. Not all admixtures are economical to employ on a particular project. Also, some characteristics of concrete, such as low absorption, can be achieved simply by consistently adhering to high quality concreting practices.

Admixtures are now widely accepted as materials that contribute to the production of durable and cost-effective concrete structures. The contributions include improving the handling properties of fresh concrete making placing and compaction easier, reducing the permeability of hardened concrete, and providing freeze/thaw resistance.

TYPES OF ADMIXTURES

Admixtures vary widely in chemical composition, and many perform more than one function. Two basic types of admixtures are available:

1) Mineral admixtures.
2) Chemical admixtures.

All admixtures to be used in concrete construction should meet specifications; tests should be made to evaluate how the admixture will affect the properties of the concrete to be made with the specified job materials, under the anticipated ambient conditions, and by the anticipated construction procedures.

1) MINERAL ADMIXTURES

Mineral admixtures (fly ash, silica fume [SF], and slag) are usually added to concrete in larger amounts to enhance the workability of fresh concrete; to improve resistance of concrete to thermal cracking, alkali-aggregate expansion, and sulfate attack; and to enable a reduction in cement content.

(a) Fly Ash
(b) Silica Fume
(c) Ground Granulated Blast Furnace Slag
(d) Rice husk ash

2) CHEMICAL ADMIXTURES

Chemical admixtures are added to concrete in very small amounts mainly for the entrainment of air, reduction of water or cement content, plasticization of fresh concrete mixtures, or control of setting time.

Seven types of chemical admixtures are specified in ASTM C 494, and AASHTO M 194 [06], depending on their purpose or purposes in PCC. Air entraining admixtures are specified in ASTM C 260 and AASHTO M 154[05]. General and physical requirements for each type of admixture are included in the specifications.

(a) Air-Entrainment agents.
(b) Water-Reducers.
(c) Set-Retarders.
(d) Accelerators.
(e) Superplasticizers.

2 .MATERIALS

2.1 CEMENT

Ordinary Portland cement (53 grade) whose Fineness – 340 m2/kg ,Specific gravity- 3.1 Initial setting time - 90 min, Final setting time – 190 min. was used.

2.2 FINE AGGREGATES

In this study used sand of Zone-II, known from the strainer examination using differing sifter sizes (10mm, 4.75mm, 2.36mm, 1.18mm, 600μ, 300μ, 150μ) grasping IS 383:1963. Whose Specific Gravity is 2.65, Water assimilation 0.6% and Fineness Modulus 2.47 was used.

2.3 COARSE AGRREGATE

The coarse aggregate utilized here with having most extreme size is 12.5mm. We utilized the IS 383:1970 to discover the extent of blend of coarse aggregate. Whose Specific Gravity is 2.65, Water absorption 0.4% what's more, Fineness Modulus 4.01 was utilized.

2.4 WATER

Portable water free from any harmful amounts of oils, alkalis, sugars, salts and organic materials was used for mixing and curing of concrete.

Microsilica 920-D used in the present study was obtained from Elkem India Pvt. Ltd., Mumbai. The properties of microsilica are tabulated.

The properties of Micro silica

Parameter	Specification	Analysis
Sio_2	% Min 85.0	89.2
Moisture content	% Max 3.0	0.4
Loss on ignition	% Max 6.0	2.2
45 micron	% Max 10	8.0
Bulk density	500-700 Kg/m^3	0.55

4.2.5. Rice Husk Ash

Rice Husk, from the locally grown mixed varieties was produced from rice mills in the locality and used. The rice husk procured thus was incinerated in open air and the properties are tabulated below.

The Physical and Chemical properties of Rice Husk Ash

S. No.	Chemical Constitut	Percentage
1	SiO_2	93.2
2	$A1_2O_3$	0.9
3	Fe_2O_3	0.45
4	MgO	0.40
5	CaO	3.15
6	KO	1.6

RESULTS

Table : Initial and final setting times, soundness of cement, compressive strength and percent change in compressive strength of cement mortar cubes at different ages made with replacement of mineral admixtures with and without superplasticizer in Ordinary Portland Cement.

4.2.6. Super plasticizer

In the present investigations super plasticizer utilized was supplied by internationally reputed admixtures manufactures. Conplast SP 430 was manufactured by Fosroc. Conplast SP 430 is based as sulphonated naphthalene formaldehyde super plasticizer. It complies with IS: 9103-1999[30].

3.1Compressive Strength

Compression test is done as per IS 516-1959. All the concrete specimens were tested in a 2000KN capacity compression-testing machine. Concrete cubes of size 15mm x 15mm x15mm are tested for crushing strength; crushing strength of concrete is determined by applying load at the rate of 140kg/sq.cm/minute until the specimens failed. The maximum load applied to the specimens has been recorded and dividing the failure load by the area of the specimen the compressive strength has been calculated. Variations of the compressive strength with various variables studied are examined. The 2000KN capacity compression-testing machine with specimen.

$$\text{Compressive strength} = \frac{Load}{Area} \text{ in N/mm}$$

S. No.	Physical Properties	Result
1	Variety	Mixed
2	Calorific value	3350 Kcal/kg
3	Specific gravity	2
4	Loss on ignition	3.6%
5	Burning	Open
6	Fineness Blains	16000 cm^2/gm

10%

SI. No.	Cement + admixture	Initial setting time (min)	Final setting time (min)	Soundness (mm)	Compressive strength MPa			
					3 day	7 day	28 day	90 day
1	OPC	123	218	0.77	28.33	37.00	44.00	49.40
2	OPC +10%MS	113	188	1.20	16.82	29.00	38.00	44.00
3	OPC +10% FA	139	224	0.29	23.02	28.60	42.50	47.33
4	OPC +10% RHA	85	200	0.50	21.16	26.00	31.90	42.67
5	OPC+ 10% GGBS	90	210	1.30	24.56	30.00	41.80	44.33
6	OPC + SP	120	240	0.58	21.66	30.00	38.70	47.80
7	OPC + 10% MS + SP	180	260	0.16	21.41	27.00	36.80	40.67
8	OPC + 10% FA+ SP	186	336	0.60	24.10	27.00	40.60	46.00
9	OPC + 10% RHA + SP	85	200	0.76	15.74	20.40	31.28	34.33
10	OPC+10% GGBS +SP	160	280	0.56	23.00	33.00	40.69	43.33

Note:SP=Superplasticizer,GGBS =Ground Granulated Blast Furnace Slag,OPC=Ordinary Portland Cement,RHA= RiceHusk Ash

CONCLUSIONS

> OPC with 10% replacement of mineral admixtures like fly ash, ground granulated blast furnace slag and microsilica with superplasticizer retards final setting time significantly, where as in the case of rice husk ash with and without superplasticizer accelerates both the initial and final setting times significantly.

> OPC with 10% replacement of fly ash, ground granulated blast furnace slag and microsilica with and without superplasticizer the percentage change in compressive strength is decreased significantly and further, it is observed that this decrease in strength slightly increases at lateral days.

> OPC with 10% replacement of mineral admixtures like fly ash, ground granulated blast furnace slag, microsilica and rice husk ash with and without superplasticizer, the loss in compressive strength in Acid Test, alkali and sulphate test is significant.

> From the test analysis it can be inferred that the PSC in all the cases performing well than that of the OPC. Hence it is preferable to use PSC.

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