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AN EXPERIMENTAL STUDY IS CONDUCTED TO DETERMINE HOW CHARACTERISTICS OF SCC METAKAOLIN AND FLY ASH AFFECT THE MECHANICAL

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ABSTRACT

Due to the absence of compaction, self-compacting concrete (SCC) has better characteristics and enhances productivity and working conditions. SCC is suited for installation in crowded reinforcement structures without causing vibration, and it aids in producing higher-quality surface finishes. However procedure of Metakaolin and Fly ash as an effective pozzalonic material which causes great enhancement in the pore structure, also compatibility is precious by the characteristics of materials and the mix proportions, it becomes necessary to evolve a procedure for mix design of SCC. The purpose of this experimental investigation is to determine how metakaolin and fly ash affect the mechanical characteristics of self-compacting concrete. In this case, fly ash is replaced with 30% in order to increase strength, and for that amount of fly ash (FA), metakaolin (MK) is substituted with percentage weights of cement, i.e. (0%, 5%, 10%, 15%, 20%). The outcomes demonstrated that the addition of metakaolin to fly ash improves the mechanical characteristics of self-compacting concrete. Additionally, the sample's results from the binary SCC test are contrasted with those from the standard test using cement, metakaolin, and fly ash.

Keywords*—Fly ash, Metakaolin, Self Compacting Concrete, Pozzalona.*

Introduction

The important pozzolanic aluminosilicate substance known as metakaolin is produced by calcining kaolin clay at temperatures between 700 and 850 °C. MK is typically added to concrete in amounts ranging from 5 to 15% of the cement's weight.

Increased mechanical strength, improved long-term strengths, decreased permeability and porosity, decreased efflorescence, and increased resistance to soluble chemicals like sulphates, chlorides, and acids are all results of adding metakaolin. Metakaolin, according to Okankarahan et al., reduces the workability of freshly mixed concrete. Super plasticizers (SP) or a higher water to binder (W/B) ratio can also lessen this drawback. Materials like Metakaolin (MK) and Fly Ash (FA) produce more calcium silicate hydrate (C-S-H) gel, obstructing already-existing pores and changing the topology of the pore network.

The mineral byproduct of burning ground or powdered coal in an electric generating station is called fly ash. [18] It has distinct divisions. Inorganic material from the coal that was fused during coal combustion makes up fly ash. Numerous characteristics of fresh and hardened

concrete are affected by it. [38] With their experimental work, Gopalakrishna S. et al. found that the addition of fly ash increased compressive strength up to 80 MPa with a 25% replacement of fly ash and that fly ash blended concretes also had improved durability attributes.

MATERIALS AND METHODOLOGY

1.Materials:

OPC (43 grade) is used for the investigation and construction works. It confirmed to the requirements of Indian standard Specification IS: 8112-1989.[27] The tests on cement are carried out as per IS: 4031-1991.IS: 383-1970 defines the fine aggregates as particles, which will pass through 2.36 mm and retained on 0.150 mm IS sieve is used. It is also called as sand. Natural river sand is used for any construction work is used in the present study[26].

Aggregate with Fineness modulus of 3.76 and specific gravity of 2.62 is used.[13] Locally available crushed granite aggregate, passing sieve of size 20mm with 60% and 40% of aggregate passing through 12.5mm retained on 6.3mm with the fineness modulus of 5.52 and specific gravity of 2.74 is used. Commercially available MK was used for this study whereas; FA was obtained from thermal power plant, tuticorin district, Tamiladu state, India.[23]

2. Chemical Admixtures:

Super plasticizer is essential for the creation of SCC. The job of SP is to impart a high degree of flow ability and deformability, however the high dosages generally associate with SCC can lead to a high degree of segregation.[33]

3. Mix Proportions and Casting Of Concrete:

Self Compacting Concrete (SCC) requires a more sophisticated mix design than conventional vibrated concrete, as well as more meticulous assurance with more testing and inspection, at least initially. The appropriate amount of goal for making a concrete with the needed strength, workability, and durability as economically as feasible is determined by the design mixing ration of concrete, which is now referred to as this mix design of concrete. [12]

While carrying the experiments it is concentrated to achieve the SCC mix without segregation and bleeding since the focus is to achieve free flow.[19]

4. Fresh state properties of SCC

Slump flow, V-funnel at 5 minutes, L-box tests were performed in the laboratory confirming to EFNARC specifications on fresh SCC mixes to find filling ability, passing ability and segregation resistance.[10]

Fig.1:*-Typical V- Funnel Apparatus*

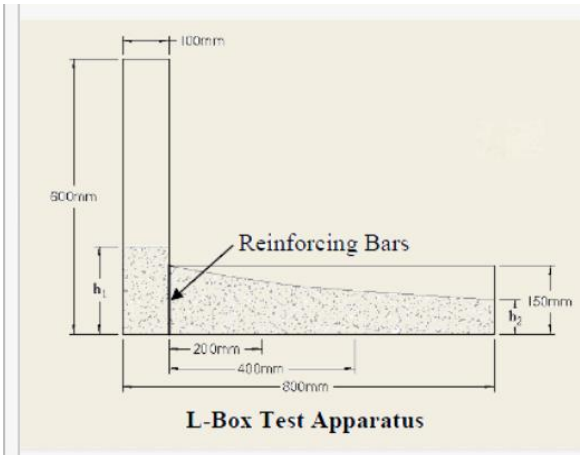

Fig.2:-*L-Box Test Apparatus*

Fig.3:-*Typical Slump Cone Test Apparatus*

Fig.4:-*Collapse slump due to water cement ratio*

5. Compressive strength of SCC

According to IS 9013-1997, the compressive strength of both the standard SCC mix and the MK and FA blended cement SCC cube were measured. For each mix, six moulds were cast, and tests were run seven and 28 days afterwards.

6. Split Tensile Strength:

After 7 and 28 days of moisture curing, splitting tensile strength tests for conventional SCC mix and a combination of MK and FA blended cement SCC cube were conducted in accordance with IS 5816-1999. 65% strength is attained after 7 days.

I. RESULTS AND DISCUSSION

After testing compressive strength after 7th day and 28th day curing period it is found that

1) It has been found that adding 10% fly ash and 20% metakaolin to cement might increase its early strength. The compressive strength achieved over a period of seven days is 35.14 MPa, or >90% of the desired strength..By observing above results the 7 days strength of normal SCC, the combination of (10%FA+20%MK, 5%FA+25%MK, 0%FA+30%MK) has shown greater results than 25%FA+5%MK, 20%FA+10%MK. This may be due to improved adhesion properties of concrete by the introduction of Metakaolin in greater amount.

2) However, rather than 30%FA+0%MK, 25%FA+5%MK, or 20%FA+10%MK, the strength obtained after the 28-day cure time for 15% FA+15% MK, %FA+20%MK, 5% FA+25%MK, and 0% FA+30%MK has attained goal strength. In terms of cost, the blend's 28-day compressive strength is 46.09 N/mm2 while the normal SCC mix's is 52.84 N/mm2. The greatest value, 5.09, is discovered in blended mix 8 with 30% MK.

3) The same changes are shown in split tensile strength, which is reported to be 5.11 N/mm2 for standard SCC and 4.27 N/mm2 for blended mix when it comes to cost. The greatest value, 5.42, is discovered in blended mix 8 with 30% MK.

Table 1:*-Chemical properties of Metakaolin and Fly ash Compared to Ordinary Portland Cement*

Type	Meta kaolin%	OPC %(43)	Fly Ash%
SiO_2	51.36	22.48	56.2
Al_2O_3	32.40	7.12	21.7
Fe_2O_3	2.31	3.01	5.93
CaO	0.78	59	4.28
MgO	0.16	1.77	1.92
K_2O	0.62	1.303	1.99
Na_2O	0.26	0.36	0.63
$S0_3$	0	4.2	0.49
L.O.I	0.98	1.5	1.78

Table 2:-*Results on Compressive Strength and Split Tensile Strength*

Blended Mix	Mix Designation	Compressive Strength in N/mm²		Split Tensile Strength in N/m²
		7days	28days	28 days
Normal SCC MIX	Mix 1	36.56	52.45	5.21
Cement+30%FA+0%MK	Mix 2	28.00	34.70	3.45
Cement+25%FA+5%MK	Mix 3	24.01	27.76	2.54
Cement+20%FA+10%MK	Mix 4	25.56	38.87	3.60
Cement+15%FA+15%MK	Mix 5	28.26	45.90	4.30
Cement+10%FA+20%MK	Mix 6	33.00	49.55	4.61

CONCLUSIONS

1) As per the observation it's set up the Fly Ash in after stages develops high strength rat her than metakaolin and cement which is proved in high volume Fly Ash Concr ete.
2) Fly ash is less reactive than metakaolin because of the difference in fineness. So that a higher percentage of mixing with metakaolin results in SCC's strength being increased.
3) Out of all the mixes, the 15%FA+15%MK mix performs the best in terms of obtaining the desired strength as well as being cost-effective, with compressive strengths of 46.47 N/mm2 and split tensile strengths of 4.27 N/mm2, respectively.
4) The time taken by blended SCC to set after casting is greater when compared with Normal concrete.
5) To achieve the appropriate properties, additional attention must be used during handling, putting, and curing special concrete.

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