Experimental Investigation On Binary & Ternary Blended Concrete

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Abstract - This paper presents the usage of SCMs usage such as flyash, alccofine as a partial replacement of cement. The concrete production involves manufacturing of cement in which huge amount of CO2 is released into atmosphere during its preparation process which causes air pollution, which is a global issue affecting the life on earth. In our experimental work, flyash and Alccofine 1203(as it contains ultra fine particles to obtain consistent mix and also acts as super plasticizer lowering water demand) are used as SCMs in preparing binary and ternary blended concrete. M30 grade Concrete cubes of size 150mmx150mmx150mm were prepared with flyash as 30% replacement of cement and flyash with 30% + Alccofine with 0%, 5%, 10%, 15%, 20%, 25% replacement of cement preparing binary and ternary blended concrete respectively. After 28days curing, cubes were tested for compressive strength and observed the optimum strength arrived at combination of alccofine 20% and flyash 30%. With the attained optimum proportion further concrete specimens were prepared to test split tensile strength and flexural strength. Hence it is concluded that replacement of cement with 20% alccofine and 30% fly ash gives better results with minimum cost of concrete and making it sustainable.

Keywords – M30 concrete, flyash, alccofine-1203, compressive strength, split tensile strength, flexural strength.

I. INTRODUCTION

One recent development in the realm of civil engineering is the creation of SCMs. Early strength development occurs when supplementary cementitious materials (SCMs) are used in different quantities because to their pozzolanic characteristics.[1]. By using more SCMs in concrete as a partial or alternative to cement, the amount of cement used can be decreased, which has a positive impact on the environment[1]. The application of SCM based concrete is gaining popularity as these SCMs are ecofriendly in nature and produce sustainable, good performance concrete. Alccofine-1203 is micro fine mineral additive with low calcium silicate obtained through the controlled granulation process[2]. The alccofine-1203 can be usedin two ways, as to replace cement and as an admixture, which lowers water demand [2]. On addition of alccofine to concrete improves the compressive strength of concrete by reducing water demand [3]. And the usage of fly ash is increasing widely in blended cement. But the flyash alone cannot be used as SCM due to its slower pozzolanic reactivity, hence it is incorporated with alccofine in concrete to attain early strength gaining and long-term strength[6]. The concrete enriched with alccofine-1203 reduces segregation, heat of hydration, permeability of concrete and increases rate of hydration, pozzolanic reaction [4]. “G. Gautham Kishore” in his experimental investigation mentioned that alccofine blended in ultra high- performance concrete (UHPC) mix, resulted in improved mechanical performance and durability, on comparing with traditional UHPC and concluded that alccofine has better suitability to act as SCM [5]. The components of alccofine-1203, such as calcium (CaO) and silica (SiO_2), enhance the mechanical qualities and longevity of concrete. Increases compressive strength when fly ash and alccofine ratios are changed[8]. When compared to the M20 control mix, Gayatri K et al. found that replacing 15% of the cement with alcofine produced good strength increases of up to 25% [7].Additional durability experiments that looked at sulphate attack, chloride attack, and RCPT also found that chloride penetration has decreased by up to 42%[7]. High compressive strength was achieved in M60 concrete using 22% flyash, 8% alcofine, and 20% flyash[9]. When compared to control concrete, mixtures containing alccofine with micro steel fibers produced a little improvement in strength in high strength concrete and durability attributes at all ages[11]The utilization of 15% alccofine in concrete yields the highest possible compressive strength[12]. Thus, we may conclude that the inclusion of alccofine improves the self-compatibility traits such as resistance to segregation, filling ability, and passing ability[12].

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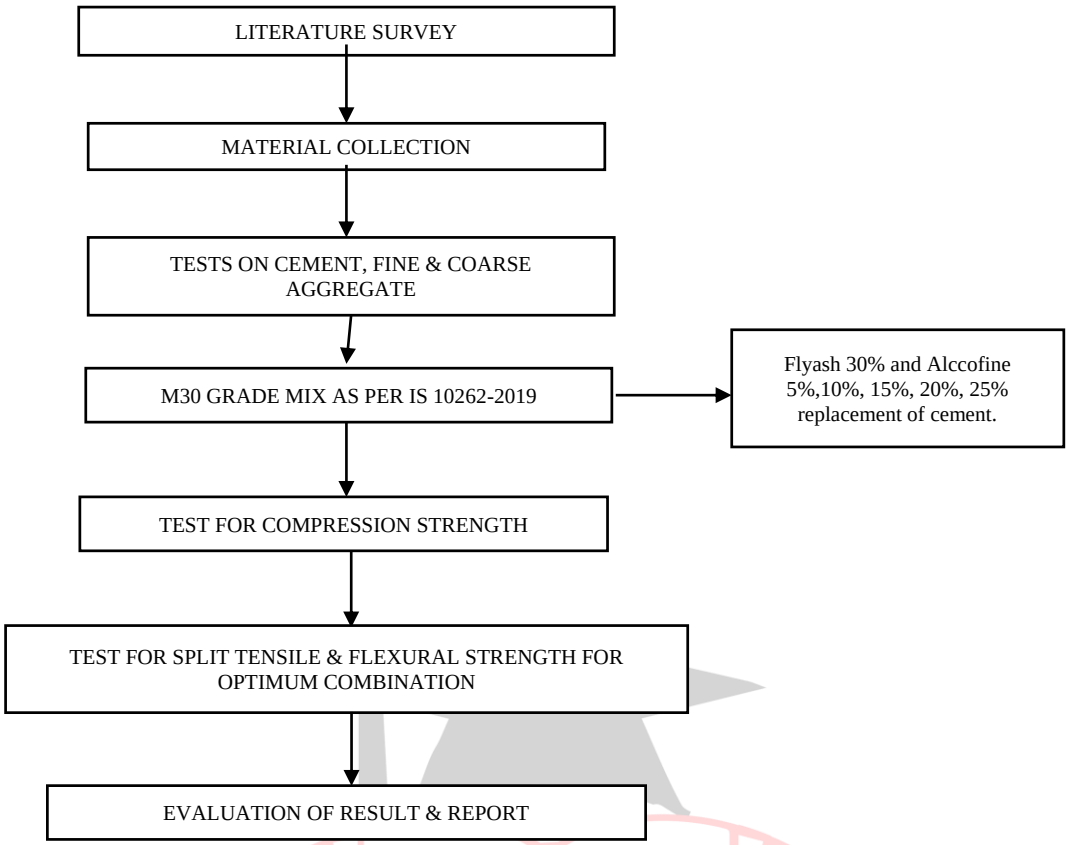
II. METHODOLOGY



III. EXPERIMENTAL STUDY

A) MATERIALS:

CEMENT:- Ordinary Portland cement-53 Grade (IS 12269: 2013).

Colour	Grey
Specific gravity	3.15
Standard consistency	34%
Initial setting time	38mins
Fineness	4%

FINE AGGREGATE: Locally available River sand, conforming to zone II per IS 383-1970. Specific gravity of fine aggregate is 2.59.

COARSE AGGREGATE: Crushed angular aggregate passing through 20mm sieve with IS 383: 2016. Specific gravity of coarse aggregate is 2.65

FLY ASH: Fly ash collected from cement factory near Aushapur, Hyderabad. Specific gravity is 2.67

ALCCOFINE: Ordered from counto microfine products pvt.ltd Hyderabad. Specific gravity is 2.86 with fineness 12000cm^3/gm.

B) MIX PROPORTION:

The mix design prepared as per code IS 10262:2019, the selected grade of concrete is M30grade.

Table 1: Mix Proportions for 1m^3 M30 Concrete

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Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water
487.5	597.6	1087.1	194.9
1	1.23	2.23	0.4

C) MIXING & CASTING

Design mix was prepared for M30 grade concrete by replacing flyash with 30% and alccofine with 5%, 10%, 15%, 20%, 25% by weight of cement. Mix proportion of modified M30 concrete with addition of flyash and alccofine are reported in table 2.

Table 2: Mix Proportions for 1m^3 flyash concrete & flyash + alccofine concrete

Material in kg/m^3	Mix proportion					
	$C_{70}F_{30}A_0$	$C_{65}F_{30}A_5$	$C_{60}F_{30}A_{10}$	$C_{55}F_{30}A_{15}$	$C_{50}F_{30}A_{20}$	$C_{45}F_{30}A_{25}$
Cement	341.25	316.87	292.5	268.13	243.75	219.37
Fine aggregate	597.6	597.6	597.6	597.6	597.6	597.6
Coarse aggregate	1087.1	1087.1	1087.1	1087.1	1087.1	1087.1
Flyash	146.25	146.25	146.25	146.25	146.25	146.25
Alccofine	-	24.37	48.75	73.125	97.5	121.88

$C_{70}F_{30}A_0$ indicates 70% cement and 30% flyash with 0% alccofine. Similarly $C_{65}F_{30}A_5$ indicates 65% cement, 30% flyash and 5% alccofine. $C_{60}F_{30}A_{10}$ indicates 60% cement, 30% flyash and 10% alccofine. $C_{55}F_{30}A_{15}$ indicates 55% cement, 30% flyash and 15% alccofine. $C_{50}F_{30}A_{20}$ indicates 50% cement, 30% flyash and 20% Alccofine. $C_{45}F_{30}A_{25}$ indicates 45% cement, 30% flyash and 25% Alccofine.

IV. RESULTS & DISCUSSIONS:

A) **COMPRESSION STRENGTH**: The specimens for compressive strength were casted and tested as per code IS 516-1999. Cubical specimens of dimensions 150mm x 150mm x 150mm, replacing 30% of cement with flyash in all mixes and alccofine varying from 0%, 5%, 10%, 15%, 20%, 25% by weight of cement were tested in compressive testing machine (CTM). The results of compressive strength test were presented in Table 3. Here $C_{70}F_{30}A_0$ is considered as control specimen for compressive strength.

S.NO.	MIX	28 days Average compressive strength (MPa)	% increase in compressive strength
1	$C_{70}F_{30}A_0$	27.25	-
2	$C_{65}F_{30}A_5$	35.36	29.7
3	$C_{60}F_{30}A_{10}$	35.61	30.6
4	$C_{55}F_{30}A_{15}$	36.82	35.1
5	$C_{50}F_{30}A_{20}$	37.31	36.9
6	$C_{45}F_{30}A_{25}$	35.93	31.8

Table 3: Compression strength results at 28 days

From the above table, it is clear that reducing cement and replacing it with flyash and alccofine has significantly increased the compressive strength at all proportions and obtained maximum strength for mix $C_{50}F_{30}A_{20}$. The percentage at which maximum compressive strength is obtained is said to be optimum proportion mix. From the above table, $C_{50}F_{30}A_{20}$ is considered as optimum mix with maximum compression strength of 37.31Mpa. Therefore we conclude 20% alccofine replacement in cement as optimum value, further split tensile strength and flexure strength tests are carried at that optimum mix proportion.

B) **SPLIT TENSILE STRENGTH**:

The split tensile strength test of concrete at the age of 28 days is carried out conforming to IS 5816-1999. Three-cylinder samples with 150mm x 300mm were prepared with mix $C_{50}F_{30}A_{20}$ obtained as optimum mix from compressive strength results. The results are tabulated in table 4.

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Table 4: Split tensile strength results at 28 days

Mix	Ultimate Load(KN)	Split tensile strength for optimum proportion specimen(MPa) $C_{50}F_{30}A_{20}$	Split tensile strength for Control specimen (MPa) $C_{70}F_{30}A_{0}$
Sample 1	135.3	7.65	6.98
Sample 2	163.6	9.25	7.17
Sample 3	143.8	8.23	7.23
Avg value	147.57	8.38	7.13

C) **FLEXURAL STRENGTH**:

At 28 days of age, the flexural strength test of concrete is conducted in accordance with IS 516-1999. Three 500 x 100 x 100 mm prism samples were made using the ideal proportion of alcofine and put to the test.And the results were presented in table 4.

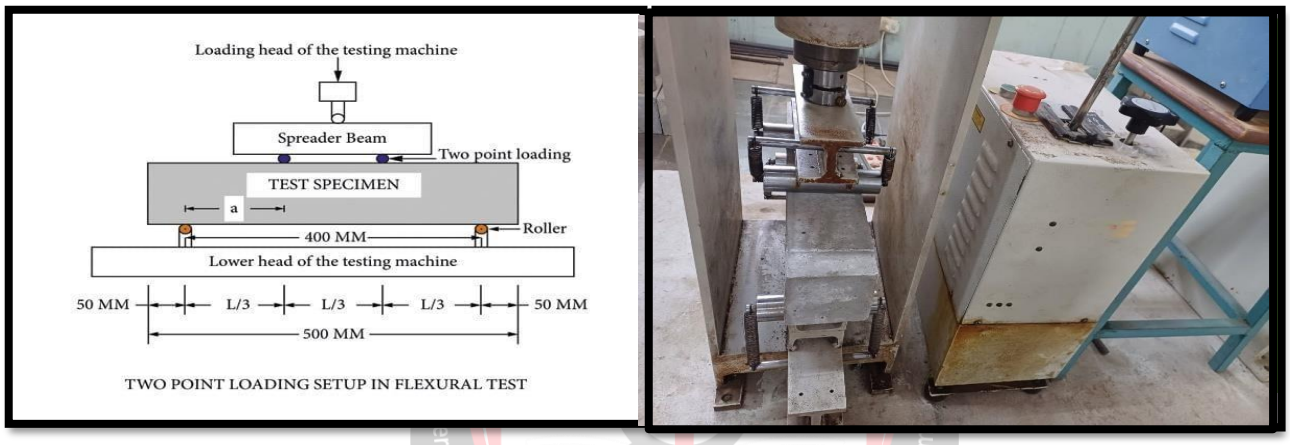

Fig. 1 Flexure strength test setup

Each prism sample is subjected to two-point loading at a distance of L/3 from each supports to obtain the flexure strength. The load arrangement is shown in fig.1.

Table 5: Flexure strength results at 28 days

Mix	Ultimate Load(KN)	Flexural strength for optimum proportion specimen (Mpa) ($C_{50}F_{30}A_{20}$)	Flexural strength test for control specimen (MPa) ($C_{70}F_{30}A_{0}$)
Sample 1	8.88	0.35	0.27
Sample 2	7.12	0.32	0.29
Sample 3	8.34	0.34	0.34
Avg values	8.11	0.34	0.30

Table 6: Percentage increase in Split tensile & Flexure strength

MIX	Avg split tensile strength (MPa)	% increase in split tensile strength	Avg Flexural strength (MPa)	% increase in flexural strength
$C_{70}F_{30}A_{0}$	7.13	-	0.30	-
$C_{50}F_{30}A_{20}$	8.38	17.53	0.34	13.33

With reference to the control specimen without alccofine, split tensile strength has increased by 17.53% and flexural strength by 13.33%, respectively, and it is evident from the above data that, at the optimal mix proportion, both tensile strength and flexural strength are greater than those of the control specimen.

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V. CONCLUSIONS

Based on test results, the following conclusions are made as per our observation.

1. The impact of flyash and alccofine on cement concrete strength is examined in this experimental study.
2. Based on our experimental study, we can conclude replacing upto 20% of cement in concrete with alccofine improves its compression, flexural and split tensile strengths.
3. While adding alccofine to all mixes enhanced the compressive strength, $C_{50}F_{30}A_{20}$ mix is regarded as the optimum combination because it produced a compression strength of 37.31MPa or a 36.39% increase in strength.
4. Similarly at 20% addition of alccofine, flexural strength and split tensile strength also rise by 13.33% and 17.53% respectively.
5. When flyash and alccofine are used more frequently, the cost of concrete lowers. Therefore, it is important to encourage the use of flyash and alccofine in building.

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