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Effect of Different Supplementary Cementitious Materials on Concrete Workability

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Abstract

Supplementary cementitious materials (SCMs)are used for to increase the strength of concrete. The supplementary cementitious materials like fly ash and GGBS (ground-granulated blast-furnace slag) are using in this project. Supplementary cementing materials hardened concrete through pozzolanic activity. In this project the comparing of regular concrete block with Supplementary cementitious materials like fly ash and GGBS (ground-granulated blast-furnace slag). The quantity of fly ash and GGBS is 0%, 10%, 20% and 30%. To compare the block taking the test like workability and strength test. For workability the slump cone test is taken and for strength test the compression test is taken. Portland cement has a high carbon footprint. Using alternative Supplementary cementitious materials for block production might reduce the carbon footprint and price.

1. INTRODUCTION

Cement is the most used material in the construction industry and is the second most highly used substance in the world. The demand for Portland cement is increasing day-by-day, and thus the cement industry has increased production of cement. Meanwhile, CO_2 emission footprint in the environment is mainly due to the production of cement, because the cement industry emits 850 kg of CO_2 per ton of clinkers . Therefore, SCMs have been used as cement replacement materials in consideration of the environmental factor.

The performance of concrete can be augmented by adding various SCMs. Furthermore, most SCMs are industrial waste products, i.e., fly ash, (FA), rice husk ash, (RHA), ground-granulated blast-furnace slag (GGBFS), silica fume (SF), etc. The addition of SCMs in the concrete not only minimizes the cement content, but also reduces costs and environmental pollution.

The main focus of this review is to demonstrate the effects of supplementary cementitious materials [SCM] on the physical, mechanical and durability properties.

2. METHODOLOGY

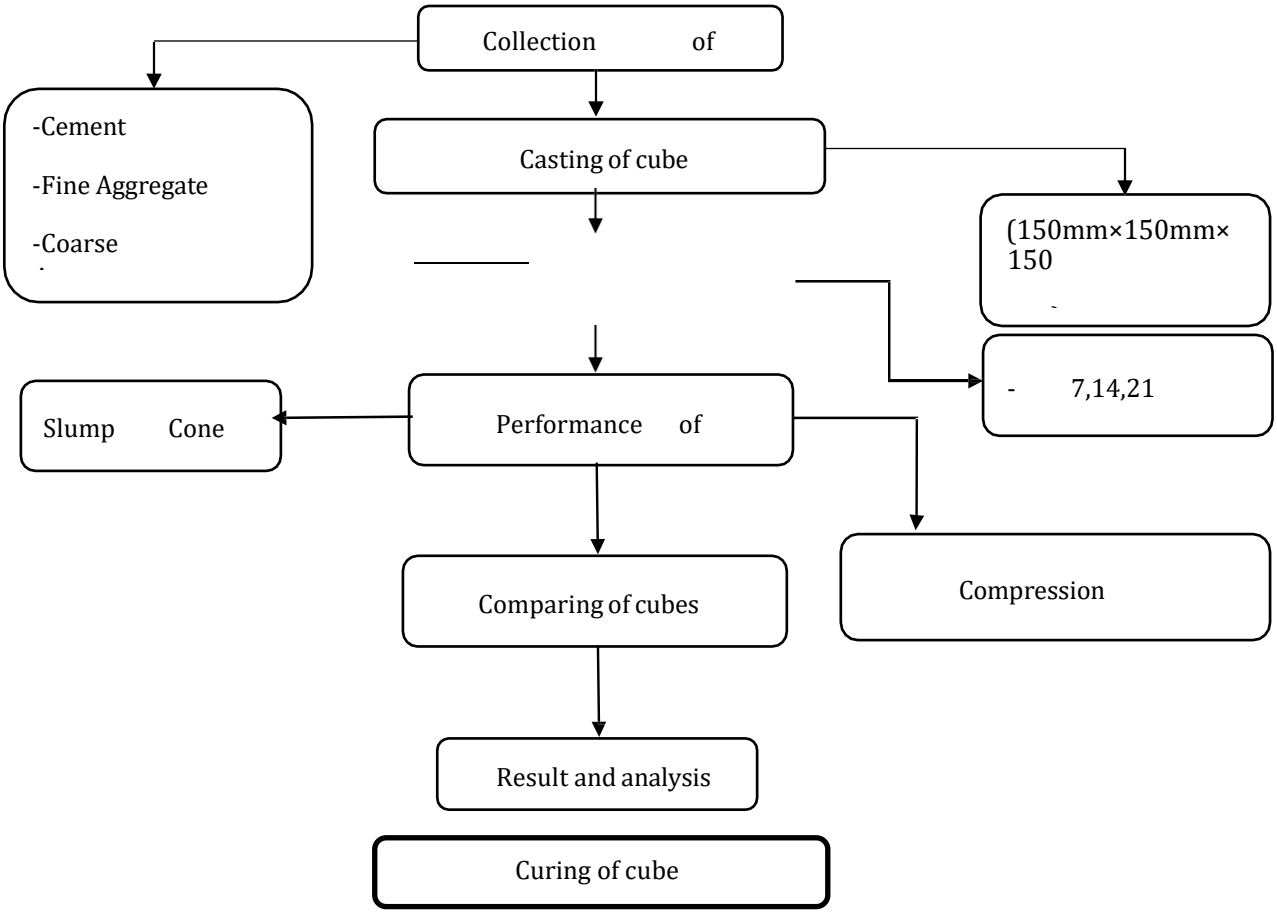


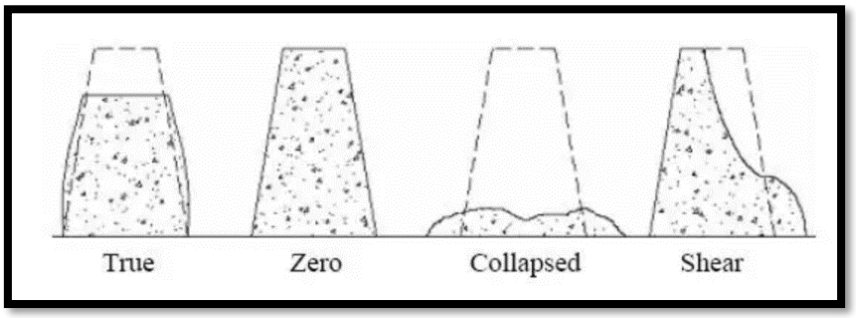
Fig. 1 Methodology

3. OBJECTIVES

- Development of concrete of grade M20 using various supplementary cementations materials.
- Use of various supplementary cementations materials in concrete.
- Compare the strength with different proportion of supplementary cementations materials.
- Compare the workability of various mixes.

4. Result and discussion

Slump cone test



Workability	Compaction Factor	Slump (mm)
Very Low	0.78	0 - 25
Low	0.85	25 - 50
Medium	0.92	50 - 100
High	0.95	100 - 175

1. Concrete block

Sample	Slump Height (mm)	Type of slump
1	78	Shear
2	64	Shear

2. 10% Fly ash

Sample	Slump Height (mm)	Type of slump
1	89	Shear
2	83	Shear

3. 20% Fly ash

Sample	Slump height (mm)	Type of slump
1	86	Shear
2	74	Shear

4. 30% Fly ash

Sample	Slump height (mm)	Type of slump
1	119	True
2	91	Shear

5. 10% GGBS

Sample	Slump height (mm)	Type of slump
1	89	Shear
2	86	Shear

6. 20% GGBS

Sample	Slump height (mm)	Type of slump
1	73	Shear
2	97	Shear

7. 30% GGBS

Sample	Slump height (mm)	Type of slump
1	86	Shear
2	91	Shear

Compression Test

Table 1.1 Concrete cube test report

Sample No	Dimensions (mm)			Date of cast	Date of test	Area (mm^2)	Max. Load (KN)	Strength (N/mm^2)
	L	H	W					
1	150	150	150	25/04/24	03/05/24	22500	217	9.64
2	150	150	150	25/04/24	10/05/24	22500	350	15.6
3	150	150	150	25/04/24	20/04/24	22500	378	16.8

Table 1.2 Fly Ash 10% test report

Sample No	Dimensions (mm)			Date of cast	Date of test	Area (mm^2)	Max. Load (KN)	Strength (N/mm^2)
	L	H	W					
1	150	150	150	31/07/24	21/08/24	22500	298	13.24
2	150	150	150	31/07/24	21/08/24	22500	261	11.6
3	150	150	150	31/07/24	21/08/24	22500	390	17.33

Table 1.3 Fly Ash 20% test report

Sample No	Dimensions (mm)			Date of cast	Date of test	Area (mm^2)	Max. Load (KN)	Strength (N/mm^2)
	L	H	W					
1	150	150	150	03/08/24	21/08/24	22500	312	13.86
2	150	150	150	03/08/24	21/08/24	22500	317	14.09
3	150	150	150	03/08/24	21/08/24	22500	329	14.62

Table 1.3 Fly Ash 20% test report

Sample No	Dimensions (mm)			Date of cast	Date of test	Area (mm^2)	Max. Load (KN)	Strength (N/mm^2)
	L	H	W					
1	150	150	150	03/08/24	21/08/24	22500	312	13.86
2	150	150	150	03/08/24	21/08/24	22500	317	14.09
3	150	150	150	03/08/24	21/08/24	22500	329	14.62

Table 1.4 Fly Ash 30% test report

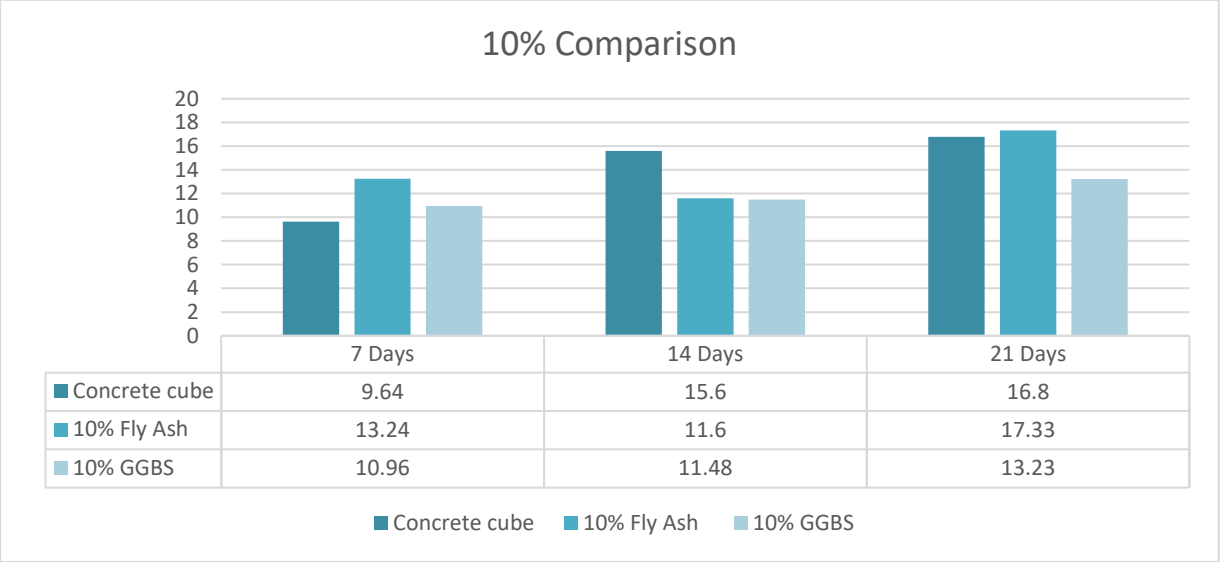
Sample No	Dimensions (mm)			Date of cast	Date of test	Area (mm^2)	Max. Load (KN)	Strength (N/mm^2)
	L	H	W					
1	150	150	150	06/08/24	21/08/24	22500	335	14.88
2	150	150	150	06/08/24	21/08/24	22500	332	14.75
3	150	150	150	06/08/24	21/08/24	22500	336	15

Table 1.7 GGBS 30% test report

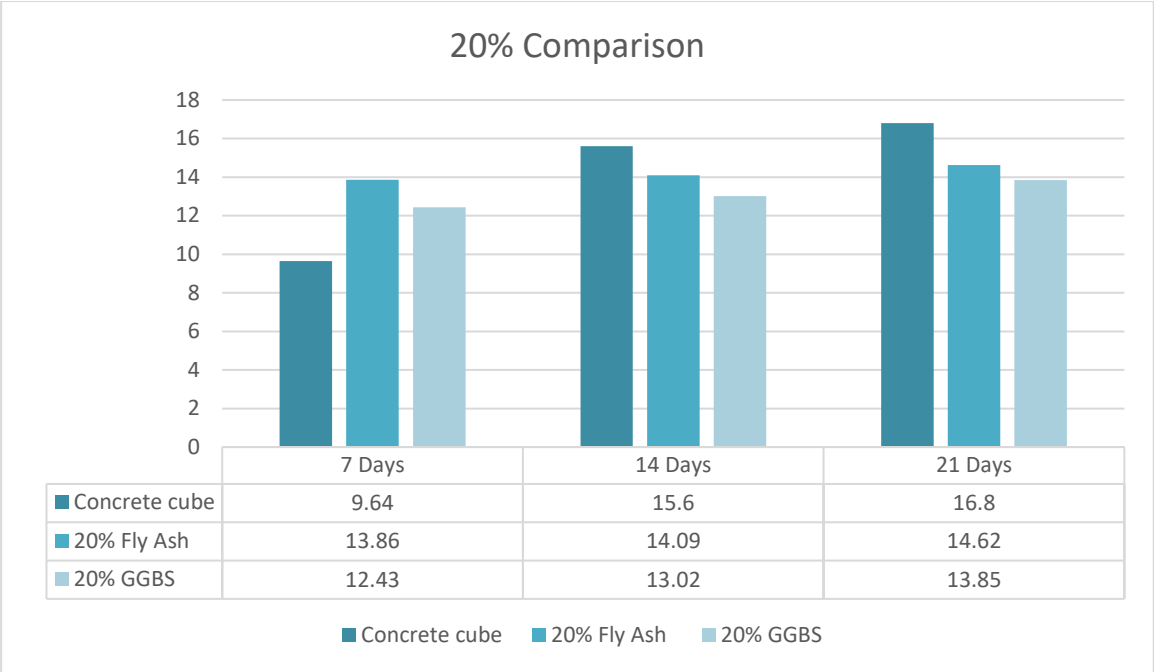
Sample No	Dimensions (mm)			Date of Cast	Date of test	Area (mm^2)	Max. Load (KN)	Strength (N/mm^2)
	L	H	W					
1	150	150	150	01/10/24	22/10/24	22500	291	15.79
2	150	150	150	01/10/24	22/10/24	22500	342	15.23
3	150	150	150	01/10/24	22/10/24	22500	355	15.79

Comparison Between Cube

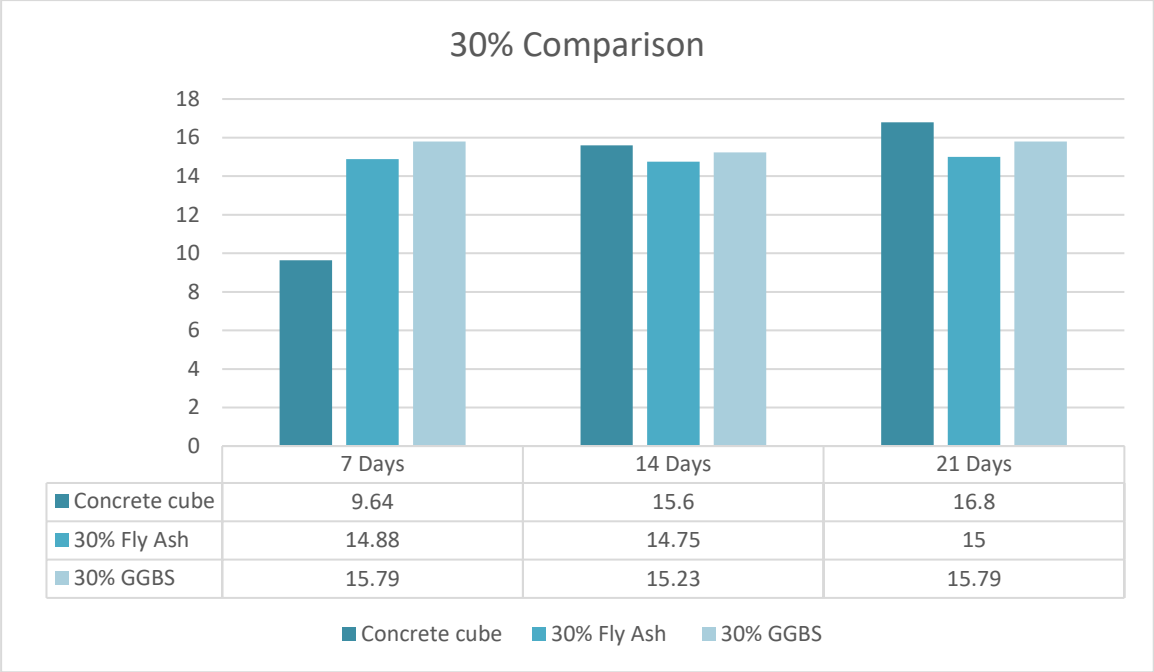
1. Comparison Between 10% materials



2.Comparison Between 20% materials



3. Comparison Between 30% materials



PHOTOS

Fig.1.Casting of cube

Fig.2.Curing of cubes

Fig.3 Ready cubes

Fig 4. Fly Ash

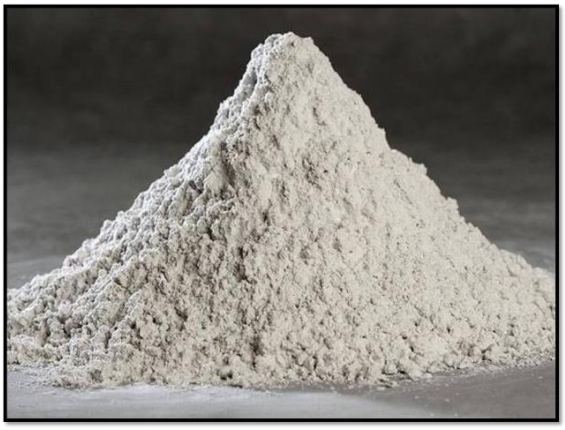


Fig 5. GGBS

Fig 6. Slump cone test

Fig 7. UTM

4. CONCLUSIONS

- **Strength**

Concrete cubes gain 65% of their strength after seven days and 90% after 14 days, and are considered fully strong after 21 days. Fly ash cubes of 10% fly ash develop compressive strength the fastest at 7 days and decreases at 14 days. Fly ash cubes with 10% fly ash develop strength up to 21 days.

Then the 20% fly ash cubes increase their strength by 7 days, 14 days, and 21 days. Similarly, 30% fly ash cubes increase their strength.

GGBS gains strength in ratio of 30% compare to 10% and 20% GGBS after 21 days. Like this 10% and 20 % GGBS cubes increses their strength maximum at 21 Days.

- **Workability**

The workability of concrete increases with the addition of fly ash, but the maximum workability is at 30% fly ash. Replacing cement with up to 10% fly ash increases slump values, but replacing cement with more than 20% fly ash increases workability.

The Workability of GGBS cubes increases maximum at 20%. And between the 10% and 30% GGBS, 30% GGBS has the good workability.

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