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A STUDY ON MECHANICAL PROPERTY OF CEMENT WITH PARTIAL REPLACING SECONDARY CEMENTITIOUS MATERIALS

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ABSTRACT

In recent years, a lot of interest has been developed among the civil engineering community regarding Secondary Cementitious Materials (SCM) in concrete. The ingredients that have to Moreover since ground granulated blast furnace slag (GGBS), Fly ash and Silica fume (Bhanja, et al., 2005) industrial by products and the quality of the end products may depend heavily on the quality of these byproducts. By considering the above threat a study was carried out in M40 grade of concrete with the fractional substitute of cement by GGBS, fly ash and silica fume with different percentages. our work presents a detailed study on its strength parameters like Compressive strength, split tensile strength and flexural strength for period of 7 days, 14 days and 28 days respectively. From this process, it reveals that the increase in fractional substitute of cement by SCMs increased the compressive, split tensile strength and flexural strength with the Partial replacement of OPC by GGBS 20 % + SF 10% gives the better result than the normal type of concrete.

Keywords Ground granulated blast furnace slag, Fly ash, Silica fume.

INTRODUCTION

Concrete which is most extensively used building material and Portland cement produce is the major supplier for the carbon dioxide emissions to the atmosphere. In this article the endeavor was made to study the strength of cementitious materi-als such as GGBS, fly ash and silica fume. Secon-dary cementitious materials (SCMs) are generally the by-products from other processes or natural materials which may or may not be processed for further use in concrete (Ahmed, 2014). Few of these materials are called Pozzolana, which does not have any cementitious properties by themse-lves. Few supplementary cementitious materials can be used as ground granulated blast furnace slag, fly ash and silica fume (Bhikshma, et al., 2009). SCMs can be utilized to develop the concr-ete performance in its clean, toughened state and are primarily used for its workability, toughness, and strength. These materials permit the concrete producer to design and transform the concrete mix-ture for the specific application.

EXPERIMENTAL PROGRAMME

In this study, mechanical property of cement (Magadeaswaran, et al., 2012) with partial replac-ing secondary cementitious materials are used to find out the compression force of cubes, split tensile strength of cylinders and flexural strength of beams on M40 grade is conducted at the research centre of Sathyabama University, Chennai. Materi-als utilized are cement (53 grade) to IS:12269, Ground Granulated Blast Furnace Slag, Fly ash, Silica fume and Aggregates. Likely river sand pass-ing through 2.36mm sieve was used and tested as per IS 2386 (part 1)-1963. Cube specimens of cas-ted M40 control mix using coarse aggregates of maximum sizes 20mm was tested as per IS 2386 (part 1) -1963 and passing crushed concrete waste through 20mm and retained on 4.75mm sieve were used as recycled coarse aggregate. The concretes are usually tested by two methods.

- Fresh Concrete Test . Hardened Test

Fresh concrete test: The new and clean concrete test is primarily used to determine the workability, which are the properties of freshly mixed concrete or mortar. The workability can be considered by conducting slump cone and compaction factor test as per IS: 1199-1959. The outputs of these trials were carried out to improve the workability and cohesiveness of the fresh concrete.

Slump cone test (IS 1199 - 1959): Figure1 shows a true slump which is obtained and indicates the uniqueness of concrete in addition to the slump value.

Figure1: Slump Cone Test

Table 1: Slump Cone Values

TRIALS	SLUMP IN mm
OPC	100
OPC + GGBS 20% + SF10%	100
OPC + GGBS 40% + SF10%	120
OPC + GGBS 20% + Fly Ash 20% + SF10%	100
OPC +GGBS 20% + RCA 30%	105

Hardened Concrete Test: The hardened concrete test is mainly used to determine the strength. There are three types of test.

- Compression strength test
- Split tensile strength test
- Flexural strength test

These specimens are prepared with the characteristic strength 40 N/mm^2.The mix design was computed according to the design specifi-cations mentioned in IS10262-2009.

RESULTS AND DISCUSSION

- Compressive Strength Test
- Split Tensile Strength Test
- Flexural Strength Test

Compressive strength test: Experiments conducted for Compression test and data's are recorded before testing for their dimensions and care has to be taken while placing the cubes in the machine, such that the load is applied to opposite sides of the cubes as casted and not to the top.

The effect of the compressive test with OPC + GGBS 20% + SF10% for a load of 1210 kN for a period of 28 days will have high compressive strength than the other trails.

Table 2: Compression Strength Test Results

S.No.	Trail Details	Strength Details (150mmx150mmx150mm)					
		Load (kN)	7 Days (N/mm^2)	Load (kN)	14 Days (N/mm^2)	Load (kN)	28 Days (N/mm^2)
1	OPC	680	30.22	850	37.40	1090	47.65
2	OPC + GGBS 20% + SF10%	750	33.05	890	39.18	1210	53.36
3	OPC + GGBS 40% + SF10%	665	29.56	830	36.89	1095	48.67
4	OPC + GGBS 20% + Fly Ash 20% + SF10%	675	30.00	780	34.67	1010	44.89
5	OPC+GGBS 20%+ RCA 30%	650	28.89	760	33.78	980	43.56

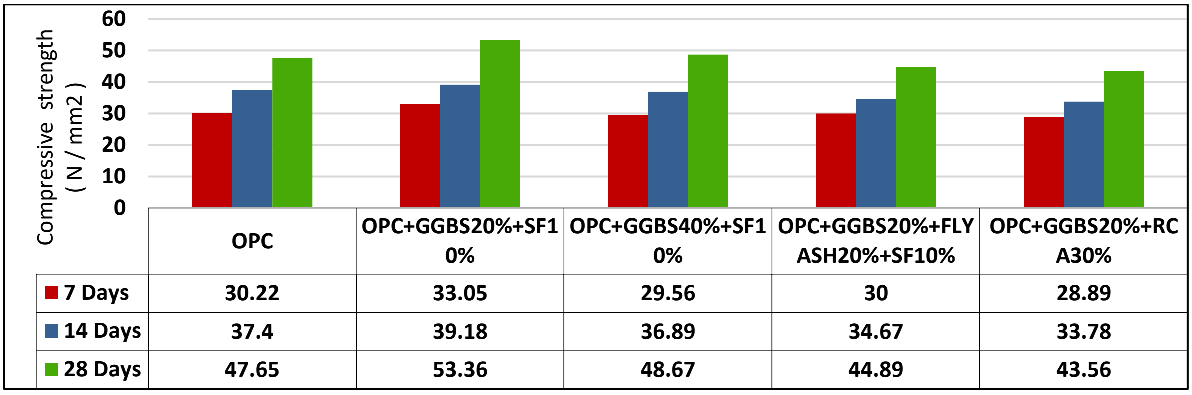

Figure 2: Flow Chart for Compression Strength Test

Table 2 shows the compressive strength details & the following figure 2 indicates flow chart for the cubes 7, 14 & 28 days. The figure 3 shows casted cubes, cylinders, beams and the specimens are cured by immersing them in a curing tank.

Figure 3: Casting Cubes, Cylinders, Beams & Curing

Split tensile strength test: Split tensile strength is performed on the cylindrical specimens indicated in the Table 3 and the size of the specimens is 150mm in diameter and 300mm in height. The effect of the Split tensile strength with OPC + GGBS 20% + SF10% for a load of 390 kN will have high compressive strength than the other trails in for a period of 14 days.

Table 3: Split Tensile Strength Test Results

S.No	Trail Details	Strength Details 150mm dia. & 300mm height					
		Load (kN)	7 Days (N/mm^2)	Load (kN)	14 Days (N/mm^2)	Load (kN)	28 Days (N/mm^2)
1	OPC	285	4.03	330	4.67	366	5.18
2	OPC + GGBS 20% + SF10%	336	4.75	390	5.52	450	6.37
3	OPC + GGBS 40% + SF10%	272	3.85	326	4.61	390	5.52
4	OPC + GGBS 20% +FLY ASH 20% + F10%	250	3.54	313	4.43	348	4.92
5	OPC + GGBS 20% + RCA 30%	240	3.39	310	4.39	370	5.23

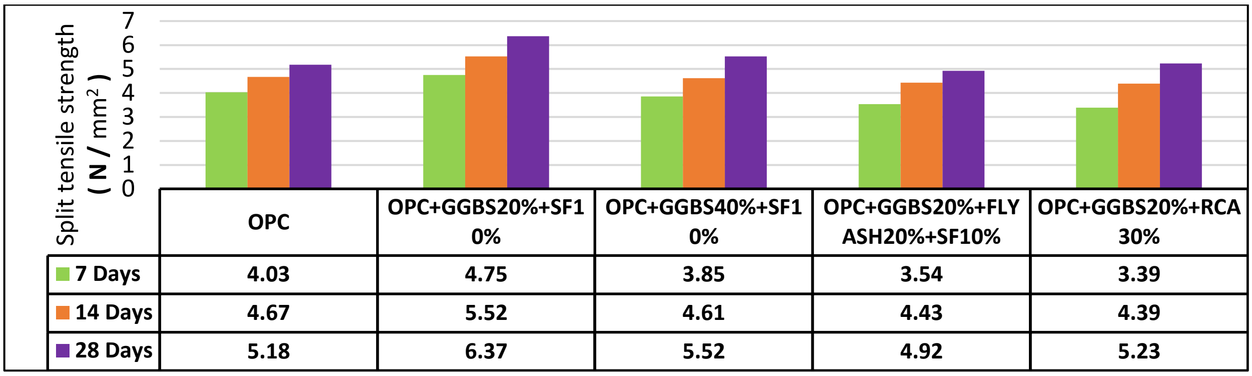

Figure 4: Flow Chart for Split Tensile Strength Test

The figure 4 indicates the flow chart for split tensile strength of cylinders at 7, 14 & 28 days.

Flexural strength test: Flexural strength is conducted on the beam specimens and the results are tabulated in the Table 4, Table 5 and Table 6

Table 4: Flexural Strength Test Results for 7 Days

Strength Details 150mmX150mmX700mm				
S.No.	Trail Details	'a' distance of crack from near support (mm)	Load (kN)	7 Days (N/mm^2)
1	OPC	215	25	4.43
2	OPC + GGBS 20% + SF10%	250	28	5.04
3	OPC + GGBS 40% + SF10%	240	24	4.35
4	OPC + GGBS 20%+ Fly Ash 20% + F10%	225	23	3.97
5	OPC+GGBS 20%+ RCA 30%	260	19	3.46

Table 5: Flexural Strength Test Results for 14 Days

Strength Details 150mmX150mmX700mm				
S.No.	Trail Details	'a' distance of crack from near support (mm)	Load (kN)	14 Days (N/mm^2)
1	OPC	240	28	5.12
2	OPC + GGBS 20% + SF10%	262	33	5.85
3	OPC + GGBS 40% + SF10%	275	29	5.20
4	OPC + GGBS 20%+Fly Ash 20% + F10%	280	28	4.97
5	OPC+GGBS 20%+ RCA 30%	230	25	4.48

Table 6: Flexural Strength Test Results for 28 Days

Strength Details 150mmX150mmX700mm				
S.No.	Trail Details	'a' distance of crack from near support (mm)	Load (kN)	28 Days (N/mm^2)
1	OPC	220	32	5.69
2	OPC + GGBS 20% + SF10%	260	38	6.76
3	OPC + GGBS 40% + SF10%	250	35	6.23
4	OPC + GGBS 20%+Fly Ash 20% + F10%	230	31	5.52
5	OPC+GGBS 20%+ RCA 30%	280	30	5.34

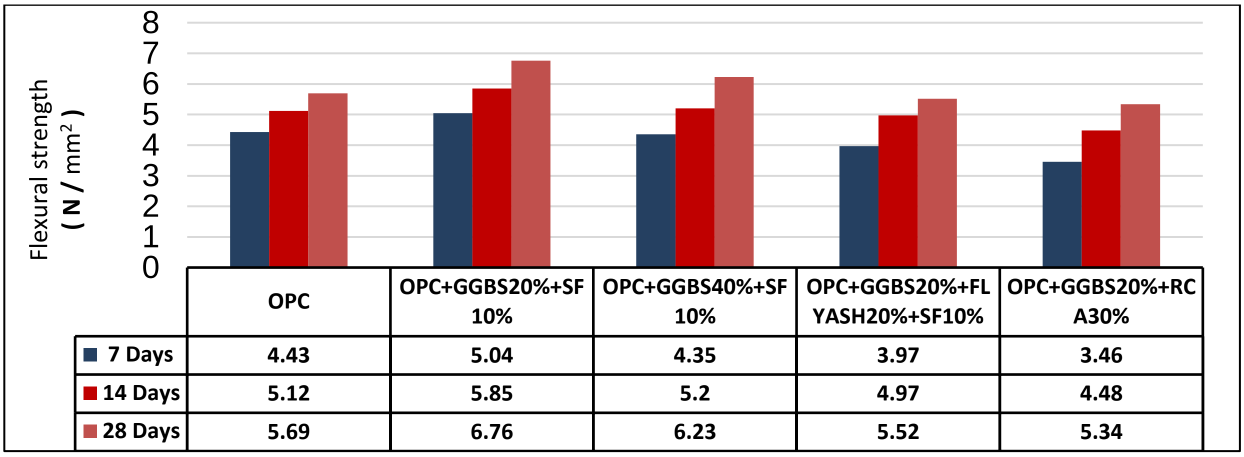

Figure 5: Flow Chart for Flexural Strength Test.

The figure 5 indicates flow chart for flexural strength of beams. The inference of this test results indicates that the Secondary Cementitious Materials can be utilised in future such as research activities, composite materials etc.,

CONCLUSION

The strengths of compressive split tensile and flexural of concrete increases with the addition of 20% GGBS + 10% SF for 28 days.

- Compressive strength for cube 12% than that of conventional concrete.
- Split tensile strength for cylinder 22.97% than that of conventional concrete.
- Flexural strength for beam 18.8% than that of conventional concrete.

The scope of the present work is that the Secondary Cementitious Materials can be replaced than the conventional cement since it has more strength and economical in cost wise based on the experimental work outputs.

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