A Experimental Investigation on Concrete Containing GGBFS with Kota Stone and Marble Stone Powder

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Abstract - *In recent years, some investigations are reported on Ground-granulated blast-furnace slag and stone based powder individually. The study reported in the report presents experimental work on combined use of Ground-granulated blast-furnace slag and Kota stone powder and with Ground-granulated blast-furnace slag and Marble stone powder in concrete and showing the comparison at various replacement levels and at various ages. The objective of the present study is to determine strength parameters of the concrete containing GGBFS with Kota stone powder and Marble stone powder. The experimental program consists of preparing concrete mixes with GGBFS as a partial replacement of cement (30% & 40%) and Kota stone powder partially replaced with sand (10% & 15%). The performance of the concrete mixes for compressive strength at various ages, flexural strength and split tensile strength was investigated.*

Key Words: *GGBFS, Kota stone powder, Marble stone powder, Compressive strength, Flexural strength.*

1. INTRODUCTION

The main aim of present study is to reduce the natural resources consumption and to reduce the burden of pollutants on environment. According to the survey, during the production of 1 ton of cement emitted 1 ton of carbon die oxide approximately, according to present scenario of world, the infrastructure spread very fast hence the requirement of cement and other construction materials also increases. Cement and natural sand are the most rapid increasing construction material. To overcome with this problem we have to find out Civil Engineering solutions hence use the materials which having properties similar to cement. The study reported in the report used GGBFS as a supplementary cementitious material and used in place of cement partially with different proportions. Factors like Economy and environment plays an essential role in the supplementary cementitious material usage and also helpful to enhance engineering and performance properties. In concrete production, another important factor is excessive sand mining which is objectionable. The available sources of sand are getting exhausted; so the alternative of fine aggregates is required partially or completely but without compromising concrete quality. Waste stone in powdered form such as marble and kota stone are such material that can be used as a replacing material for fine aggregate.

The focus of the study is to investigate the combined behaviour of GGBFS and mixture of Kota stone powder and Marble powder in concrete. M 40 Grade of concrete for the study has been picked,

2. Raw Materials Characteristics

Marble stone is a metamorphic type rock which is composed of re-crystallized carbonate minerals, calcite or dolomite is the common minerals. The formation of marble is basically due to the metamorphism action on limestone. Limestone is subjected to the heat and pressure of metamorphism; it is composed primarily of the mineral calcite ($CaCO_3$) and usually contains other minerals, such as clay minerals, micas, quartz, pyrite, iron oxides, and graphite

GGBFS is obtained by quenching molten iron slag from a blast furnace in water or stream, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS is used to make durable concrete structures in combination with ordinary Portland cement or other pozzolanic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia for its superiority in concrete durability, extending the life span of buildings from fifty to a hundred years. GGBS reacts like Portland cement when in contact with water. The mineral admixture used for this experimental work is Ground-granulated blast-furnace slag

Kota stone powder - Kota stone is the most commonly used building materials. The Industry's disposal of the Kota stone powder slurry material consisting of very fine particles. This Kota stone powder slurry having lime stone qualities because Kota stone is a fine grained variety of limestone. This Kota Stone Powder is neglected as waste in several factories.

Super plasticizer - Super plasticizer (Sika-Plastiment) was used @ 1% of weight of cement. Specific gravity of Sika-Plastiment is 1.12 (as per manufacturer).

3. CONTROL MIX

Control mix was designed as per IS 10262:2009. Typical Computations are given below:

Table -1: Control mix

S. No	Materials	Weight
1.	Cement	391Kg
2.	Coarse aggregate	1177 Kg
3.	Fine aggregate	692 Kg
4.	Water	168 Ltr
5.	Admixture (1 % of cement)	3.15 Ltr
6.	W/C Ratio	0.43

4. RESULTS

4.1 The Slump test results of control mix and concrete prepared with 20%, 30% and 40% replacement of cement by Ground granulated blast-furnace slag and 10% and 15% replacement of fine aggregate by Kota stone powder slurry are presented in Table 2 and 3

Table -2: Slump Variation with KSP

S.No	GGBFS	Kota Stone Powder		
		0%	10%	15%
1.	30 %	66	63	62
2.	40 %	69	65	64
3.	0% (CONTROL MIX)	59		

Table -3: Slump Variation with MSP

S.No	GGBFS	Marble Stone Powder Slurry		
		0%	10%	15%
1.	30 %	66	65	64
2.	40 %	69	67	69
3.	0%(CONTROL MIX)	59		

From table 2 it is observed that the slump of mix increase compared to the control mix but the mix prepared only with GGBFS having more slump than the mix of GGBFS and KSP combined.

From table 3 it is observed that the slump of mix increase compared to the control mix but the mix prepared only with GGBFS having more slump than the mix of GGBFS and MSP combined.

4.2 The Comparison of Compressive strength results of concrete specimens with 30% replacement of cement by Ground granulated blast-furnace slag and 10% and 15% replacement of fine aggregate by Kota stone powder or Marble stone powder at the age of 28 days are presented in Table 3

Table 3 Compressive strength with 30% GGBFS

OPC + GGBFS	Sand + KSP/MSP	Compressive Strength (N/mm²) 28 DAYS	
		Sand + Kota Stone Powder	Sand + Marble Stone Powder
100+0	100+0	47.9	47.9
70+30	100+0	47.23	47.23
	90+10	45.6	44.2
	85+15	44.72	41.91

The Comparison of Compressive strength results of concrete specimens with 40% replacement of cement by Ground granulated blast-furnace slag and 10% and 15% replacement of fine aggregate by Kota stone powder or Marble stone powder at the age of 28 days are presented in Table 5

Table 5 Compressive strength with 40% GGBFS

OPC + GGBFS	Sand + KSP/MSP	Compressive Strength (N/mm²) 28 DAYS	
		Sand + KSP	Sand + MSP
100+0	100+0	47.9	47.9
60+40	100+0	48.66	48.66
	90+10	47.11	47.01
	85+15	45.21	43.98

4.3 The Comparison of Flexural strength test results of concrete specimens with 30% and 40% replacement of cement by Ground granulated blast-furnace slag and 10% and 15% replacement of fine aggregate by Kota stone powder slurry at the age of 28 days are presented in Table 6 and 7

Table -6: Variation in Flexural Strength with 30% GGBFS (28 days)

OPC + GGBFS	Sand + KSP/MSP	Flexural Strength (N/mm²) 28 DAYS	
		Sand + KSP	Sand + MSP
100+0	100+0	4.71	4.71
70+30	100+0	4.79	4.98
	90+10	4.58	4.55
	85+15	4.48	4.50

Table -7: Variation in Splitting tensile strength with 40% GGBFS (28 days)

OPC + GGBFS	Sand + KSP/MSP	Flexural Strength (N/mm²) 28 DAYS	
		Sand + KSP	Sand + MSP
100+0	100+0	4.71	4.71
60+40	100+0	4.98	4.98
	90+10	4.79	4.67
	85+15	4.63	4.61

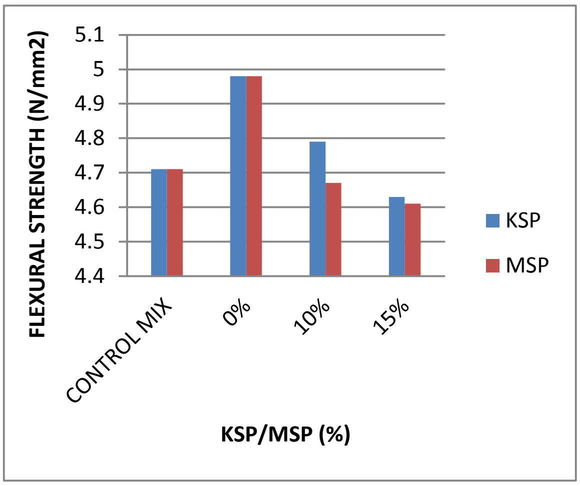

Chart -1: Variation in Flexural Strength with 30% GGBFS

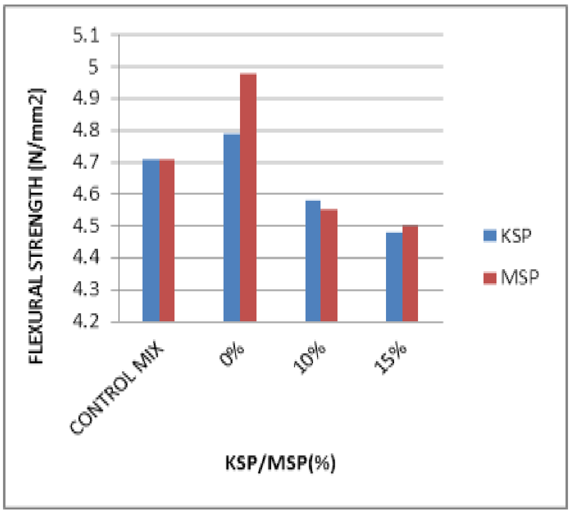

Chart -2: Variation in Flexural Strength with 40% GGBFS

4.4 The Comparison of Splitting tensile strength test results of concrete specimens with 30% and 40% replacement of cement by Ground granulated blast-furnace slag and 10% and 15% replacement of fine aggregate by Kota stone powder slurry at the age of 28 days are presented in Table 8 and 9

Table -8: Variation in Splitting tensile strength with 30% GGBFS (28 days)

OPC + GGBFS	Sand + KSP/MSP	Split tensile Strength (N/mm²) 28 DAYS	
		Sand + KSP	Sand + MSP
100+0	100+0	3.55	3.55
70+30	100+0	3.61	3.61
	90+10	3.44	3.41
	85+15	3.34	3.30

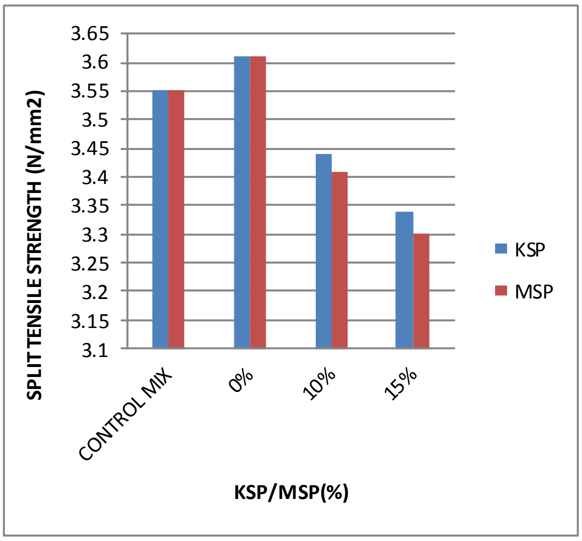

Chart -3: Variation in Split tensile Strength with 30% GGBFS

Third set of bars show the Split tensile strength results for 28 days with 10% replacement of KSP and MSP with sand and it is observed according to results that the Split tensile strength of mix prepared with 10% KSP is 0.9% more that the strength achieved with 10% replacement of MSP. Similarly for 15% replacement level the flexural strength of KSP is around 1.2% higher than that of MSP.

Table -9: Variation in Flexural Strength with 40% GGBFS (28 days)

OPC + GGBFS	Sand + KSP/MSP	Split tensile Strength (N/mm²) 28 DAYS	
		Sand + KSP	Sand + MSP
100+0	100+0	3.55	3.55
60+40	100+0	3.74	3.74
	90+10	3.56	3.51
	85+15	3.48	3.45

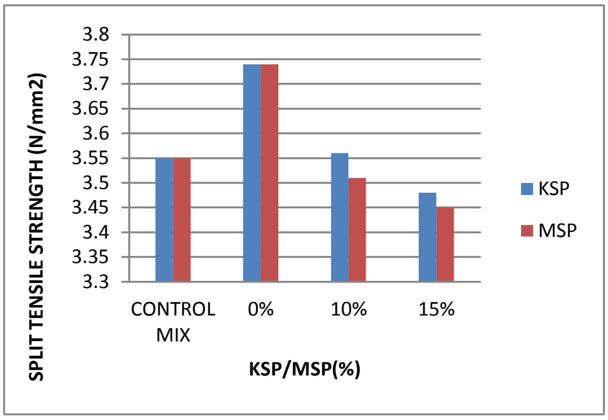

Chart -4: Variation in Split tensile Strength with 40% GGBFS

Third set of bars show the Split tensile strength results for 28 days with 10% replacement of KSP and MSP with sand and it is observed according to results that the Split tensile strength of mix prepared with 10% KSP is 1.4% more that the strength achieved with 10% replacement of MSP. Similarly for 15% replacement level the flexural strength of KSP is around 0.8% higher than that of MSP.

3. CONCLUSIONS

The Value of slump increases with increase of GGBFS content in the mix, but it slightly reduces with increase in the content of Kota stone powder or Marble stone powder in the mix.

Compressive strength In the mixes with 30% and 40% GGBFS, if fine aggregate is partially replaced by Kota stone powder in the range 10% to 15% and \also Marble stone powder in the same range then mix with Kota stone powder and 40% GGBFS provides better compressive strength at the age of 28 days

Flexural strength

In the mixes with 30% GGBFS, if fine aggregate is partially replaced by Kota stone powder and Marble stone powder in the range 10% to 15%, then flexural strength of mix with Kota stone powder was found better and more close to the Control mix However the flexural strength reduces with increase the percentage of both the stone waste in the mix. With KSP the strength reduced around 1.5 to 3.5%, while with MSP the strength reduced around 3.5% to 5% when compared to the Control mix.

In the mixes with 40% GGBFS, if fine aggregate is partially replaced by Kota stone powder and Marble stone powder in the range 10% to 15%, then flexural strength of mix with both the stone waste powder was observed better with 10% replacement and slightly reduction in strength noticed with 15% replacement in comparison to the Control mix.

Splitting tensile strength

In the mixes with 30% GGBFS, if fine aggregate is partially replaced by Kota stone powder and Marble stone powder in the range 10% to 15%, then Splitting tensile strength of mix with Kota stone powder was found better that of mix with Marble stone powder However the Splitting tensile strength reduces with increase the percentage of both the stone waste in the mix. With KSP the strength reduced around 3 to 5%, while with MSP the strength reduced around 4% to 7% when compared to the Control mix.

In the mixes with 40% GGBFS, if fine aggregate is partially replaced by Kota stone powder and Marble stone powder in the range 10% to 15%, then Splitting tensile strength of mix with both the stone waste powder was observed lesser for 15% replacement and satisfactory strength results noticed with 10% replacement level compared to the Control mix.

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