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EXPERIMENTAL STUDY OF CERAMIC WASTE POWDER AND GGBS CONCRETE OF M25 GRADE

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ABSTRACT

Concrete is exceptionally dominant in compression but vulnerable in tension. The cost of concrete by partial replacement of cement from ceramic waste powder and GGBS is diminished. The ceramic industry inevitably produces wastes, irrespectiveof the advancements introduced in manufacturing processes. In the ceramic industry, about 15%-30% of output goes as waste. In this research study, the (OPC) cement has been replaced by ceramic waste powder accordingly in the range of 10%, to 40% by weight for M-25 grade concrete and in addition, cement is also replaced by 10%- 40% of GGBS. Specimens of size 150X150X150mm were cast with and without ceramic waste powders by replacing cement and GGBS. The outcome confirms core compressive strength (30% increases) achieved up to 20% replacement of ceramic waste powder and GGBS without simulating the characteristic strength of M25. Compressive strength is increased up to 30-40% and more from the ordinary concrete for most ofthe mixes.

Keywords: Compressive strength, GGBS, Ceramic waste powder, Waste material utilization.

I. INTRODUCTION

Concrete could be a solvent of cement, sand, coarse combination, and water. Concrete is that the substance of different wherever strength, performance, durability, solidity, hearth resistance, and abrasion resistance square measure needed. Concrete stirred up ought to be strong equal to carry the load and sturdy adequate so structure created lives for its design life. it's wide used for creating subject area structures, foundations, brick/block walls, pavements, bridges/overpasses, highways, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences, and poles, and even boats. It's utilized in giant quantities virtually all over humankind wants infrastructure. The quantity of concrete used worldwide, ton for ton, is double that of steel, wood, plastics, and aluminum combined. Concrete's use within the modern times is exceeded solely by that of present water. Concrete is additionally the premise of an oversized industrial trade. In an exceedingly contemporary state, it's essential to own a reasonably high degree of cohesiveness, pump ability, slump retention, and conjointly self-compacting nature. In an exceedingly hardened state, properties like high early strength and late strength, high coefficient of elasticity, low creep, dimensional stability, low porosity, salt and chloride resistance, chemical resistance, frost resistance, and abrasive resistance square measure needed in combos reckoning on the sort of structure being created and its setting.

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1.1 CERAMIC WASTE POWDER

Ceramic waste is one in every of the foremost active analysis areas that cover many disciplines as well as technology and construction materials. Ceramic waste powder is settled by deposit then drop away which ends in environmental pollution, additionally to forming mud in summer and threatening each agriculture and public health. Concrete with fractional cement that is substituted by ceramic powder however its minor strength loss holds rise in durability performance. Ceramic waste is part replaced within the style of combination, sand, and cement.

1.2 GGBS

Blast furnace slag could be a by-product of the iron producing trade. Iron ore, coke, and rock square measure fed into the chamber, and also the ensuing liquefied scum floats higher than the liquefied iron at a temperature of concerning 1500oC to 1600oC. The liquefied scum encompasses a composition of half-hour to four-hundredth silicon oxide (SiO_2) and some four-hundredth CaO that is getting ready to the chemical composition of hydraulic cement. Once the liquefied iron is abroach off, the remaining liquefied scum that in the main consists of oxide and aluminous residues is then speedily water- quenched, leading to the formation of a glassy granulate. This glassy granulate is dried and ground to the specified size that is thought as ground coarse furnace scum (GGBS). The replacement of hydraulic cement with GGBS can result in a big reduction of greenhouse gas emissions. GGBS is thus associate as environmentally friendly construction material.

II. LITERATURE REVIEW

A lot of work has been done to explore the benefits of using pozzolanic materials in making and enhancing theproperties of concrete. Literature review of Ceramic Waste powder, GGBS is presented in the following sections.

2.1 CERAMIC WASTE POWDER

F. Pacheco Torgal1 et al., (2010): presented the result of a study on compressive strength and durability properties of ceramic wastes-based concrete. Several concrete mixes possessing a target mean compressive strength of 30MPa were prepared with 20% cement replacement by ceramic powder. A concrete mix with ceramic sand and granite aggregates was also prepared as well as a concrete mix with natural sand and coarse ceramic aggregates. The mechanical and durability performance of ceramic waste-based concrete are assessed utilizing mechanical tests, water performance, permeability, chloride diffusion, and also accelerated aging tests.

D. Tavakolia et al., (2012): presented the study on the properties of concrete produced with waste ceramic tile aggregate and a large bulk of ceramic tiles change into wastage, these waste materials are not reusable and recyclable due to their physical and chemical structure. Given the high amount of concrete production and the possibility of wastage materials in them, using ceramic wastage could be an effective measure in maintaining the environment and improving the properties of concrete. The characteristics of ceramic aggregate are measured and then being grind they are used in concrete as the substitute for coarse aggregates with 0 to 40% of substitution and also for sand with 0 to 100% of substitution. Besides, all other parameters are constant.

Amit Kumar D. Raval et al., (2013): working on the effective replacement of cement for establishing sustainable concrete. Ceramic waste is one of the most active research areas that encompass several disciplines including civil engineering and construction materials. Ceramic waste powder is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. In this research study, the (OPC) cement has been replaced by ceramic waste powder accordingly in the range of 0%, 10%, 20%, 30% 40%, & 50% by weight of M-20 grade concrete. The Compressive Strength of **M20 grade** Concrete increases when the replacement of Cement with Ceramic Powder up to **30% replaces** by the weight of Cement and further replacement of Cement with Ceramic Powder decreases the Compressive Strength.

2.2 GGBS

Shariq et al.(2008): Studied the effect of curing procedure on the compressive strength development of cement mortar and concrete incorporating ground granulated blast furnace slag. The compressive strength development of cement mortar incorporating 20, 40, and 60 percent replacement of GGBFS for different types of sand and strength development of concrete with 20, 40, and 60 percent replacement of GGBFS on two grades of concrete are investigated. Tests results show that incorporating 20% and 40% GGBFS is highly significant to increasethe compressive strength of mortar after 28 days and 150 days, respectively.

Gidion Turu'allo(2015): Ground granulated blast furnace slag (ggbs) is a waste material generated from iron production, and is one of the cementitious materials that can be used to replace part of the cement in concrete. This research aimed to determine the effects of the water-binder ratios and levels of GGBS in concrete, on the activation energy, which is needed for predicting the concrete's strength.. The activation energies were determined using the American society for testing and materials (ASTM) standard C1074, and the Freiesleben Hansen and Pedersen (FHP) method.

M.S.Chennakesava Rao (2016): One of the main challenges now confronting the concrete industry in India is to meet the demand posed by enormous infrastructure needs due to rapid industrialization and urbanization. With the shrinkage of natural resources to produce ordinary Portland cement (OPC), increased use of suitable industrial waste materials having pozzolanic characteristics that can replace cement clinker is one of the ways to meet the challenge. Such a policy has many-fold advantages- utilization of industrial waste in an eco-friendly way, preserving resources, and finally, the improvement in properties of concrete culminating in the sustainable development of the society. Minimizing greenhouse gas emissions associated with the manufacturing of OPC. This research study presented the study of the behavior of high volume of slag concrete and OPC concrete.

III. MATERIAL PROPERTIES

The properties of the material used for making concrete mix were determined in the laboratory under controlled conditions as per relevant IS codes of practice. The material characterization was carried out for all the major ingredients of concrete which include cement, coarse aggregates, fine aggregates, and water. The purpose of the characterization is to check their acceptability as per relevant Indian standards to enable an engineer to design a concrete mix for a particular strength. The properties of the various materials used in this study are discussed in the succeeding sub-sections.

3.1 Cement

Cement is the most active component of concrete and usually has the greatest unit cost, thus, its selection and proper use are important in obtaining the most economical balance of properties desired for any particular concrete mixture. It fills up voids existing in the fine aggregate and makes the concrete impermeable. It provides strength to concrete by binding the aggregate into a solid mass due to its setting and hardening properties when mixed with water. Although it constitutes only about 20% of the total volume of concrete mix, its contribution to the compressive strength of concrete is the maximum.

Table 3. 1: Properties of ordinary Portland cement

Characteristics		Values Obtained	Standard value	Method of Test Ref.
Specific Gravity		3.14	--	IS 4031 part 11
Normal Consistency		33%	--	IS 4031 part 4
Initial/Final Setting-time (minutes)		84 min/210mins	30 (minimum) / 600(maximum)	IS 4031 part 5
Fineness		1%	<10	
Compressive strength (N/mm^2)	**At 3 days**	**26.1**	23	IS 4031 part 6
	At 7 days	**35**	33	IS 4031 part 6
	At 28 days	**47.9**	43	IS 4031 part 6

3.2 AGGREGATE

Aggregate occupies a large volume in concrete mixture and gives dimensional stability to concrete. In cement concrete, to provide good quality of concrete, aggregates are generally used in two size groups: coarse aggregates – Particle size more than 4.75 mm and fine aggregate particle size less than 4.75mm. Coarse aggregates make the solid and hard mass of concrete with cement and sand and increase the crushing strength of concrete. It also reduces the cost of concrete, since it occupies es major volume. The fine aggregate assists the cement paste to hold the coarse particle in suspension this action promotes plasticity in the mixture and prevents the possible segregation of paste and coarse aggregate. The aggregate must be proper in shape, clean hard, and well-graded

Table 3.2: All in aggregate gradation

a] Coarse Aggregate							
IS Sieve size (mm)	Analysis of Coarse aggregate fraction (% Passing)		% of different Fractions		Combined % passing	Limits as per IS:383 - 1970	Remarks
	20 mm	10 mm	20 mm	10 mm			
			60%	40%			
40	100.00	100.00	60.00	40.00	100.00	100	Confirming to table 2 of
20	94.72	100.00	56.83	40.00	96.83	95-100	

10	4.51	96.57	2.70	38.63	41.33	25-55	IS: 383 - 1970
4.75	0.59	3.19	0.35	1.28	1.63	0-10	

b] Fine Aggregate

IS Sieve size (mm)	Percentage of passing fine aggregates	Limits as per IS:383-1970	Remarks
10	100.00	100	Confirming to Zone-II of table 4 IS:383 - 1970
4.75	96.63	90-100	
2.36	87.04	75-100	
1.18	68.43	55-90	
600 mic	41.17	35-59	
300 mic	12.40	8-30	
150 mic	3.83	0-10	

c] All in Aggregate Gradation (CA: FA)

IS Sieve size (mm)	Coarse aggregate	Fine Aggregate	CA (60%)	FA (40%)	Combined % passing	Limit as per IS:383-1970	Remarks
40	100.00	100	60.00	40.00	100.00	100	Confirming to table 2 of IS: 383 - 1970
20	96.83	100	58.10	40.00	98.10	95-100	
4.75	1.63	96.63	0.98	38.65	39.63	30-50	
600 mic	0	41.17	0.00	16.47	16.47	10-35	
150 mic	0	3.83	0.00	1.53	1.53	0-6	

3.3 CERAMIC WASTE POWDER

Ceramic material is hard, rigid. It is estimated that 15% to 30% of waste is produced of total raw material used, and although a portion of this waste may be utilized on-site, such as for excavation pit refill. The principal waste coming into the ceramic industry is ceramic powder, specifically in powder forms. Ceramic wastes are generated as waste during the process of dressing and polishing.

Table 3.6: Chemical Properties of ceramic waste is as per table.

Materials	Ceramic Powder (%)	Materials	Ceramic Powder (%)
SiO2	63.29	Na2O	0.75
Al2O3	18.29	SO3	0.10
Fe2O3	4.32	CL-	0.005
Cao	4.46	TiO2	0.61
MgO	0.72	SrO2	0.02
P2O5	0.16	Mn2O3	0.05
K2O	2.18	L.O.I	1.61

3.4 GGBS

The GGBS enhances concrete workability due to its surface properties and fineness (approximately 460 Blaine (m2/kg.min)). According to this author, this makes GGBS 2-3 times finer than Portland cement, leading to an enhanced workability and a better performance in bleeding and setting times

Table 3.7: Chemical Properties of GGBS is as per table.

S.no.	Constituents	Proportion
1	Cao	32-34
2	Al_2O_3	18-20
3	Fe_2O_3	1.8-2
4	SO_3	0.3-0.7
5	MgO	8-10
6	SiO_2	33-35

Table 3.8: Physical Properties of GGBS is as per table

S.no.	Characteristics	Value
1	Bulk Density	600-700kg/m3
2	Surface Area	12000cm2/gm
3	Particle shape	Irregular

MIX PROPORTIONS FOR TRIAL NUMBER 1

Cement = 360.00 kg/m3
Coarse aggregate = 1261.40 kg/m3
20 mm (60%) = 756.84 kg/m3
10 mm (40%) = 504.56 kg/m3
Fine aggregate = 775.82 kg/m3
Water = 144.00 kg/m3
Chemical admixture = 2.56 kg/m3
Water cement ratio = 0.40
Ceramic waste Powder = 10%-40% by weight replaced with cement
GGBS = 10%-40% by weight replaced with cement

IV. RESULTS

The main function of the concrete in structure is mainly to resist the compressive forces. When a plain concrete member is subjected to compression, the failure of the member takes place, in its vertical plane along the diagonal. The vertical cracks occur due to lateral tensile strain. A flow in the concrete, which is in the form of the microcrack along the vertical axis of the member will take place on the application of axial compression load and propagate further due to the lateral tensile strain.

Table 4.1 Strength of concrete with different percentages of GGBS (10% to 40%) and Ceramic Waste Powder (10% to 40%).

TRIAL MIXES	PERCENTAGE OF GGBS	PERCENTAGE OF Ceramic Waste Powder	COMPRESSIVE STRENGTH (07 days N/mm^2)	COMPRESSIVE STRENGTH (28 days N/mm^2)
1	0	0	21.4	31.0
2	10	0	21.9	33.2
3	20	0	22.5	34.8
4	30	0	22.0	34.4

5	40	0	21.9	33.7
6	0	10	21.7	31.7
7	10	10	21.9	35.0
8	20	10	22.7	35.2
9	30	10	21.6	34.9
10	40	10	21.3	33.6
11	0	20	20.6	33.4
12	10	20	22.3	35.6
13	20	20	22.6	35.9
14	30	20	22.3	35.1
15	40	20	21.9	34.8
16	0	30	21.6	34.2
17	10	30	21.7	34.5
18	20	30	22.1	34.1
19	30	30	21.3	33.9
20	40	30	20.8	33.4
21	0	40	20.5	33.2
22	10	40	20.4	33.0
23	20	40	20.0	32.6
24	30	40	19.5	32.2
25	40	40	19.3	31.9

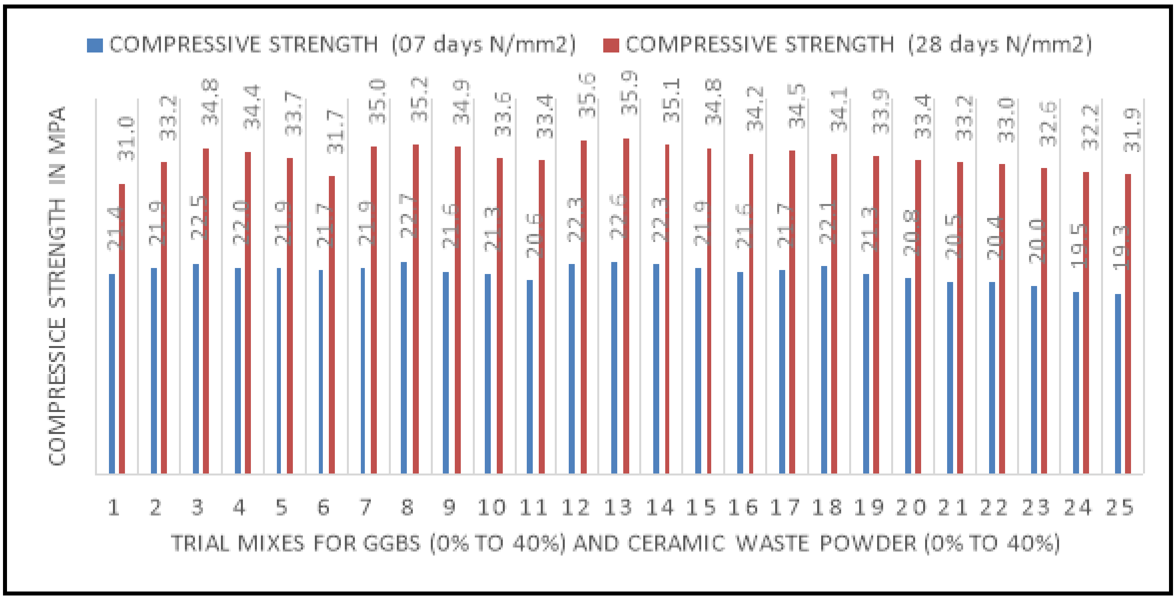

Figure4.1: Compressive strength of the different mixes of the cubes

V. CONCLUSION

The optimum replacement level of ceramic waste powder is found to be 20% with a 30% increment in compressive strength for the M25 grade of concrete. By the addition of GGBS to the mix, an increment is noticed in thecompressive strength is increased at 28 days.

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