Study on Partial Replacement of Fine Aggregate With Glass Powder And Cement With Ceramic Powder

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Abstract- *The aim of the project is to replace the natural cement and fine aggregate with rejected wastes from ceramic industry and glass industry in the concrete. The ceramic tiles powder down size of 90µ as cement and glass powder passes from 4.75µ IS sieve as fine aggregate in concrete. And it also reduces the cost of construction of concrete as compared conventional concrete. At the present 0.7% of glass waste products and 5-30% of ceramic tiles waste products are generated in India yearly. In this project the cement and fine aggregate are replaced in concrete with different three proportions (15% ceramic tiles powder & 30% glass powder), (20% ceramic tiles powder & 20% glass powder)& (25% ceramic tiles powder & 10% glass powder), and then we prepared the cubes, beams & cylinder. The tested results were discussed.*

Keywords- Ceramic waste powder (CWP), Glass powder (GP)

I. INTRODUCTION

Concrete is the world's most man-made material. It is the most widely used construction material because of its high compressive strength and flexibility in structural forms as it can be placed and molded into many shapes. Concrete have the capability to be combined with steel or recently carbon or glass fiber reinforcements to form structural elements. Moreover, its adaptability and relative durability properties relative to other construction materials gave concrete its preferable characteristics.

Due to the high material consumption of the construction industry, the utilization of waste glass as a Partial replacement for fine aggregate in a concrete is particularly attractive. This project aimed to determine the level of glass replacement resulting in optimal compressive strength. For concrete samples were tested at 7, 14 and 28 days, for glass replacement proportions of 0, 10, 20 and30% by its weight. The amount of waste glass produced has gradually increased over the recent years due to an ever growing use of glass products. Most waste glass has and is being dumped into landfill sites. The land filling of waste glass is undesirable because waste glass is non-biodegradable which makes them environmentally less friendly.

Indian ceramic production is 100 Million ton per year. In the ceramic industry, about 15%-30%waste material generated from the total production. This waste is not recycled in any form at present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces. The Ceramic industries are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. This leads to serious environmental and dust pollution and occupation of a vast area of land, especially after the powder dries up so it is necessary to dispose the Ceramic waste quickly and use in the construction industry. As the ceramic waste is piling up every day, there is a pressure on ceramic industries to find a solution for its disposal. The advancement of concrete technology can reduce the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement materials offer cost reduction, energy savings, superior products, and fewer hazards in the environment.

II. LITERATURE REVIEW

Study by Electricwala Fatima, AnkitJhamb, Rakesh Kumar (2013) shows that Ceramic dust is produced as waste from ceramic bricks industries. Concrete was made by replacing 30% of cement (OPC) with ceramic dust (passing 75µm) shows good workability. The results show that with water – cement ratio (0.46), core compressive strength increase by 3.9% to 5.6% by replacing 20% cement content with ceramic dust. Ceramic waste, aggregate and cement to prepare required samples. Cement, aggregate and sand was used as per IS 456-2000 codal provision for construction of cement concrete road. The experimental investigation was done to determine Compressive strength, Flexural strength of Split Tensile strength of concrete mixed with different ratios of 10%, 20% and 30% ceramic dust for DLC dry link concrete.

Whereas, SerkanSubası a HakanÖztürk b Mehmet Emirog˘lu(2017) depicts the use of filler materials finer than 0.125 mm is quite effective on the fresh state properties, strength and durability of self-consolidating concretes. Usability of granulate waste ceramic powder as filler material in self-consolidating concretes was investigated. Cement was replaced with (CPW) ceramic waste powder in the amounts of 5%, 10%, 15% and 20% (by weight) were determined in the fresh and hardened phases. Compressive strength, split tensile strength, ultrasonic pulse velocity and bond performance of the SCC mixes were evaluated experimentally. Flow ability of the fresh concrete was improved with the increase of WCP ratio.

A study led by Dima M. Kannan a, Sherif H. Abu-Bakr b, Amr S. EL-Dieb a, Mahmoud M. RedaTaha b (2017) shows high performance concrete (HPC) mixtures incorporating 10–40% ceramic waste powder (CWP) as replacement of Portland cement by mass were evaluated. It is shown that concrete incorporating CWP as large replacement of cement has high strength and excellent durability. It is evident CWP clearly has two effects; first, a filler effect enabling it to create a dense packing system that favours high performance concrete. Second, a pozzolanic effect that is more pronounced at later ages compared with early age.

However Ponnapati. Manogna1, M. Sri Lakshmi2 (2015) conducted a study illustrating the behavior of concrete with partial replacement of tile powder in cement accordingly in the range of 0%, 10%, 20%, 30%, 40%, and 50% by weight for M30 grade of concrete. The following tests are carried out, i.e., compressive strength, tensile strength and flexural strength for 7, 28 and 56 days. The test results shows that the compressive strength, split-tensile strength and flexural strengths are achieved up to 30% replacement of cement with tile powder without affecting the characteristic strength of M30 grade concrete. The compression split tensile and flexural strength of M30 grade concrete increases when the cement is replaced with tile powder up to 30% and further replacement of cement with tile powder decreases the strength gradually.

Moreover Dr. B. Krishna Rao, Manthena. Sri Lakshmi (2013) study justifies that Portland cement can be partially replaced by cementitious and pozzolanic materials especially those of industry by-products such as fly ash, GGBS, silica fume ceramic waste powder and metamorphic rock dust form stone cutting industry. Waste ceramic materials may become a cheaper but almost equivalent alternative to metakaolin or ground granulated blast furnace slag, fly ash and other materials as supplementary binder in concrete. Compressive strength test, split tensile strength test and flexural strength test were conducted at the end of 7, 28, 56 days on the concrete specimens. The compressive strength of the tile dust concrete has varied from 29.20 to 38.27MPa and the split tensile strength is varied from 2.49-3.02MPa and flexural strength is varied from 4.26-4.88MPa for 28 days for different percentage replacements. But it is observed that the strength decreased slightly for 30% replacement so, the strength loss is almost negligible and the decrement of strength is more for 40% and 50% replacements. Hence up to 30% replacement of cement in concrete by tile dust is considerable.

R. Malathy, Kongu Engineering College, India K. Subramanian,K Subramanian has proposed that efficiency factor for silica fume and metakaoline at various replacements levels and concludes that the proposed method of mix proportioning combined the use of super plasticizer and cement replacing material for obtaining economical HPC mix.

SadicAzeez, RemyaRaju, Dr. P.R Sreemahadevan Pillai Conducted a study determining the mechanical properties of concrete specimens in which fine aggregate and cement are replaced with quartz and grog. And also fine aggregate alone is replaced with different percentage of quartz and grog. The optimum replacement possible for fine aggregate and cement with quartz and grog is 5% to 30%.

III. OBJECTIVES

To evaluate the utility of glass and ceramic waste powder as a partial replacement of fine aggregate and cement in concrete up to 5-30% with a different proportions.

To study and compare the performance conventional concrete and glass and ceramic waste powder concrete.

Recycling waste materials like glass, ceramic powder for concrete preparing will be done.

IV. MATERIALS

A. Cement

In this experiment OPC 53 grade with brand name BIRLA SUPER cement has been used. The Ordinary Portland Cement of 53 grades conforming to IS: 8112-1989 is used. The cement used was fresh and without any lumps.

Table 1: properties of cement

Properties	Magnitude
Specific gravity	3.125
Initial setting time	35 min
Final setting time	447 min
Fineness of cement	89%

B. Fine aggregate

M sand is used as fine aggregate in this study. The conforming to zone II passing through 4.75mm IS sieve.

Table 2: properties of fine aggregate

Properties	Magnitude
Specific gravity	2.54
Water absorption	1%
Fineness modulus	3.69
Bulk density	1830 kg/m^3
Grading zone	Zone II

C. Coarse aggregate

Table 3: properties of coarse aggregate

Properties	Magnitude
Specific gravity	2.59
Water absorption	1%
Fineness modulus	2.26
Bulk density	1340 kg/m^3
Particle size	20 m

D. Ceramic powder

Ceramic powder is obtained as by product of ceramic industry, also known as grog, fire sand and chamotte, is a ceramic raw material. It has high percentage of silica and alumina. It can be produced by firing selected fire clays to high temperature before grinding and screening to specific particle sizes. The particle size distribution is generally coarser in size than the other raw materials used to prepare clay bodies. It tends to be porous and have low density.

Fig.1. Ceramic powder

Table 4: properties of ceramic powder

Properties	Magnitude
Specific gravity	2.56
Fineness modulus	2.78
Bulk density	970 kg/m^3

Table 5: chemical composition of ceramic powder

Oxides	%
SiO2	1.44
Fe2O3	11.57
MgO	13.64
K2O	0.21
SiO2	1.44
Fe2O3	11.57
MgO	13.64
K2O	0.21

A. Glass powder

Glass powder (GP) used in concrete making leads to greener environment. In shops, damaged glass sheets & sheet glass cuttings are go to waste, which are not recycled at present and usually delivered to landfills for disposal. Using GP in concrete is an interesting possibility for economy on waste disposal sites and conservation of environment.This project examines the possibility of using GP as fine aggregate replacement in concrete. Natural sand was partially replaced (0%-30%) with GP in concrete.Tensile strength, Compressive strength (cubes and cylinders) and Flexural strength up to 28 days of age were compared with those of high performance concrete made with natural sand.

Fig. 2 Glass powder

Table 6: properties of glass powder

Properties	Magnitude
Specific gravity	2.52
Fineness modulus	3.39
Bulk density	1328 kg/m^3

Table 7: chemical composition of glass powder

Sio2	63.29
Al2o3	18.29
Fe2o3	4.32
CaO	4.46
MgO	0.72
P2O5	0.16
K2O	2.75
Na2o	0.75

V. MIX PROPORTIONING

The process of determining required and specifiable characteristics of a concrete mixture is called mix design. Characteristics can include fresh concrete properties, required mechanical properties of hardened concrete such as strength and durability requirements and the inclusion, exclusion, or limits on specific ingredients. Mix design leads to the development of a concrete specification. In the present investigations a mix of M30 grade concrete was used and designed as per relevant Indian Standard specifications.

Table 8: mix details for m30 grade of concrete

Cement	Fine aggregate	Coarse aggregate	w/c ratio
438 Kg	819.5 Kg	1120 kg	0.45

Following are the mixes considered for the study

COVVENTIONAL CONCRETE - Cement + MSand + CA
1st PROPORTION - 15%CWP + 30%GP + 85%Cement + 70%MSand + CA
2nd PROPORTION - 20%CWP + 20%GP + 80%Cement + 80%MSand + CA
3rd PROPORTION - 25%CWP + 10%GP + 75%Cement + 90%MSand + CA

Weigh batching is done for all materials. All aggregates used in the mix were weighed under surface dry conditions. Laboratory mixer is used for mixing the components of concrete. Coarse aggregate, fine aggregate and cement were added to the mixer and they are mixed thoroughly. Water is then added and is mixed for 5 minutes. Standard cubes, cylinders and beams were casted for all mixes in concrete.

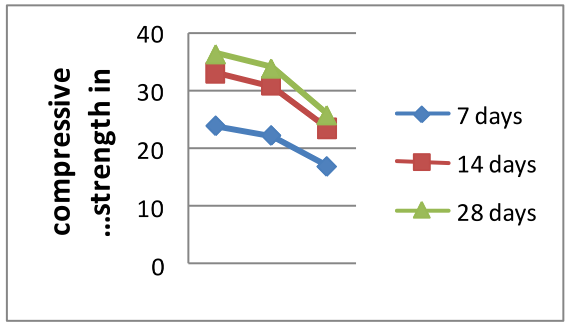
VI. RESULTS AND DISCUSSIONS

A. Compressive Strength

Compression tests are used to determine how a product or material reacts when it is compressed, squashed, crushed or flattened by measuring fundamental parameters that determine the specimen behavior under a compressive load. Compression test are conducted at the end of 7th, 14th and 28th day of casting the specimens. The load was applied without any shock and continuously until the failure of the specimens. The maximum load is applied to the specimens until failure is recorded.

Table 9: compressive strength for 7, 14 & 28 days as follow

Average compressive strength in N/mm^2	7 days	14 days	28 days
1st PROPORTION	23.95	33.21	36.52
2nd PROPORTION	22.30	30.92	34.02
3rd PROPORTION	17.0	23.55	25.84

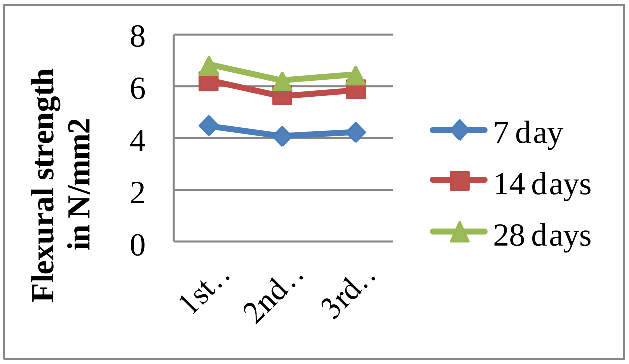


B. Flexural Strength

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

Table 10: flexural strength for 7, 14 & 28 days as follow

Average flexural strength in N/mm^2	7 days	14 days	28 days
1st PROPORTION	4.50	4.10	4.25
2nd PROPORTION	6.23	5.67	5.88
3rd PROPORTION	6.85	6.24	6.47

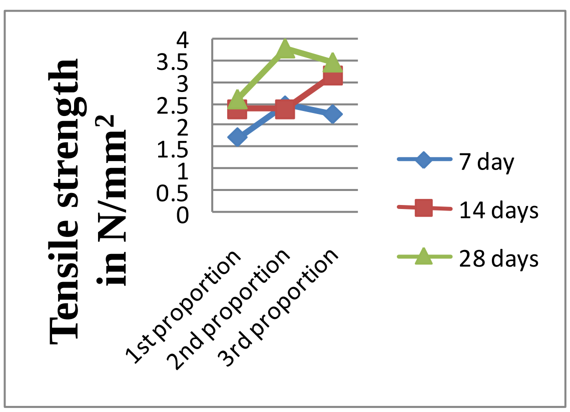


C. Split Tensile Strength

Tensile strength is one of the basic and important properties of concrete. Knowledge of its value is required for the design of concrete structural elements subject to transverse shear, torsion, shrinkage and temperature effects. Its value is also used in the design of pre stressed concrete structures, liquid retaining structures etc. The cylindrical specimen shall have diameter not less than four times the maximum size of the coarse aggregate and not less than 150 mm. The length of the specimens shall not be less than the diameter and not more than twice the diameter.

Table 11: split tensile strength for 7, 14 & 28 days as follow

Average tensile strength in N/mm^2	7 days	14 days	28 days
1st PROPORTION	1.73	2.49	2.28
2nd PROPORTION	2.39	2.40	3.17
3rd PROPORTION	2.64	3.80	3.48



VII. CONCLUSIONS

The objective of study is to determine the mechanical properties of concrete specimens (compressive strength, Spilt Tensile strength, Flexural strength) In which fine aggregate is replaced with glass powder and cement is replaced with ceramic powder.

1. The replacement of fine aggregate with glass powder and cement with ceramic powder of 30% and 15% respectively.
2. The compressive strength of concrete 7, 14, & 28 days are 23.95 N/mm^2 33.21 N/mm^2& 36.52 N/mm^2
3. The replacement of fine aggregate with glass powder 20% and cement with ceramic powder is 20%.
4. The compressive strength of concrete 7, 14, & 28 days are 23.30 N/mm^2 30.92 N/mm^2& 34.02 N/mm^2
5. The compressive strength of concrete with replacement of glass powder 10% to fine aggregate and ceramic powder 25% to cement are 17 N/mm^2 23.55 N/mm^2& 25.84 $N/mm^{2.}$

Based on the above replacement the three different proportions are design to the M30 grade of concrete. The 1st and 2nd proportions compressive strength is more than 30N/mm^2 as per design. We are able to replace mixture of ceramic and glass powder in concrete up to 20% to get strength above 30N/mm^2 as per M30 grade. We are unable to use above 20% of both mixture of ceramic and glass powder in concrete. If it is used above 20% as per M30 grade design, then compressive strength we will get less than 30 N/mm^2, this is not safe for design.

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