International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.8, pp 74-80, 2017

Experimental Study on Partial Replacement of Coarse Aggregate with Ceramic Tile Wastes and Cement with Glass Powder

B.Kavitha*, M. Lenin Sundar

Department of Civil Engineering, Sri Krishna College of Technology, Coimbatore, India

Abstract : This present world is very much depends on the concrete for the construction of various infrastructural activities. Concrete has become a basic need for every structure nowadays. The increasing population of the world puts a lot of pressure on the civil engineer to develop a cost effective as well as an eco-friendly structure according to the need of human beings. Concrete is a heterogeneous mixture of binding material (cement or lime), coarse aggregates, fine aggregates (sand) and water. Fine and coarse aggregates are obtained from quarrying of large rocks which leads to a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem. The objective of this research is to study the utilization of glass powder and ceramic waste as partial replacement of cement and coarse aggregate in concrete. The properties such as flexural strength and compressive strength of concrete incorporating glass powder and ceramic waste in partial replacement of cement and coarse aggregate were examined and compared. The flexural strength and compressive strength was determined at the age of 7 days and 28 days. Cubes for compressive strength as dimensions 150x150x150mm and for flexural beams of dimension 500x100x100mm were casted adopting weight batching and hand mixing. The mix were designated as a mix with varying percentage of ceramic waste such as 0 percent,5 percent,15 percent,25 percent and 35 percent to evaluate various properties. The research has been conducted on M30 mix grade. The results which come out from the research work are shows that the strength developed in concrete is increased, it can be equated to higher strength concrete and it can be easily used as construction material in construction work.
Keywords : Ordinary Portland Cement, Waste Ceramic Tiles, Waste Glass Powder.

1.0 Introduction

Concrete is one of the important construction material used in the world in all engineering works including the infrastructure development at all stages. It has been used in construction sector for a long time and proved that, it is a cheap material and its constituents are widely available in nature. Due to wide spread usage and fast infrastructure development in all over the world, there is shortage of natural aggregates[4]. The quality of concrete is determined by its mechanical properties as well as its ability to resist the deterioration[1]. The mechanical properties are classified into two categories; they are short-term properties and long-term properties. Strength, elasticity modulus and bonding characteristics come under short-term (instantaneous) properties. Creep, shrinkage, fatigue and durability come under long-term properties. It's a great opportunity for the concrete industry that they can save natural aggregate by replacing coarse aggregate with construction demolition waste and other waste materials like ceramic waste aggregates, granite waste aggregate and Cuddapah slab waste aggregate in the production of concrete. Pozzolanic concretes are used extensively throughout the world where oil, gas, nuclear and power industries are among the major users. The applications of such concretes are increasing day by day due to their superior structural performance, environmental friendliness, and energy conserving implications Research has been conducted on the use of fly ash, volcanic ash, volcanic pumice, pulverized-fuel ash, blast slag and silica fume etc. as cement replacement material[4.] Fly ash and others are pozzolanic materials because of their reaction with lime liberated during the hydration of cement. These materials can also improve the durability of concrete and the rate of gain in strength and can also reduce the rate of liberation of heat, which is beneficial for mass concrete. Concretes containing mineral admixtures are used extensively throughout the world for their good performance and for ecological and economic reason. Ceramic is a taken from Greek word ‘keramos’ means potters clay. Ceramic materials are non metallic, inorganic compounds – primarily compounds of oxygen, but also compounds of carbon, nitrogen, boron, and silicon[7]. Originally, the art of making pottery, now a general term for the science of manufacturing articles prepared from pliable, earthy materials that are made rigid by exposure to heat.

2.0 Significance of Work

To find out the engineering properties of ceramic tile wastes and glass powder.To overcome the high utilization of cement and coarse aggregate due to the developing infrastructure. To determine the strength of the concrete by replacing cement and coarse aggregate with glass powder and ceramic tile wastes respectively. It deals with the problem of greenhouse gas emission and avoids landfill disposal of ceramic tile wastes.

3.0 Mix Material

3.1 Ceramic Tiles

A ceramic material is an inorganic, non-metallic, often crystalline oxide, nitride or carbide material[5]. Some elements, such as carbon or silicon, may be considered ceramics. Ceramic materials are brittle, hard, and strong in compression, weak in shearing and tension. They withstand chemical erosion that occurs in other materials subjected to acidic or caustic environments. Ceramics generally can withstand very high temperatures, such as temperatures that range from 1,000 °C to 1,600 °C (1,800 °F to 3,000 °F). Glass is often not considered a ceramic because of its amorphous (non crystalline) character. However, glassmaking involves several steps of the ceramic process and its mechanical properties are similar to ceramic materials. Traditional ceramic raw materials include clay minerals such as kaolinite, whereas more recent materials include aluminium oxide, more commonly known as alumina. The modern ceramic materials, which are classified as advanced ceramics, include silicon carbide and tungsten carbide.

i. Chemical Properties

The composition of tiles are illustrated below,

a. SiO2 : 56-64 %
b. Al2 O3 : 15-17 %
c. K2O :2-3 %
d. Na2O :0.5-1.5 %
e. CaO : 5-5.7 %
f. MgO :0.5-0.6 %
g. L.O.I. : 6-7 %

3.2 Glass Powder

Glass is an amorphous (non-crystalline) that in essence, a super cooled liquid and not a solid[2]. Glass can be made with excellent homogeneity in a variety of forms and sizes from small fibres to meter-sizes pieces. Primarily glass is made up of sand, soda ash, limestone and other additives (Iron, Chromium, Alumina, Lead and Cobalt)[2,6]. Glass has been used as aggregates in construction of road, building and masonry materials.

i. Physical Proporties Of Glass Powder

Table 1: Physical properties of glass powder

Specific gravity	2.73
Medium particle size	90µm
Moisture content (%)	0.1%

ii. Chemical Properties

Table 2:Chemical properties of glass powder

Silica (SiO2)	72.5
Alumina (Al2O3)	0.4
Iron Oxide (Fe2O3)	0.2
Calcium Oxide (CaO)	9.7
Magnesium Oxide (MgO)	3.3
Sodium Oxide (Na2O)	13.7
Potassium Oxide (K2O)	0.1

3.3 Coarse Aggregate

Aggregates composed 60 -75 % of production of concrete. Act as inert filler materials used in production of concrete. These diagrams show various aggregates weight classification and it mainly used for production purpose.

3.4 Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970. The specific gravity of sand is 2.60 and fineness modulus is 3.30. The free and compacted bulk density values obtained are 1645 Kg/m3 and 1780 Kg/m3 and water absorption is 1.10%.

3.5 Water

Water is an important factor of concrete as it actually participates in the chemical reaction with cement. Portable water is employed in fusing of concrete.

3.6 Cement

Cement acts as a binding agent for materials. Cement as applied in Civil Engineering Industry is produced by claiming at high temperature. It is admixture of calcareous, siliceous, aluminous substances and crushing the clinkers to a fine powder. Cement is the most expensive materials in concrete and it is available in different forms. When cement is mixed with water, a chemical reaction takes place as a result of which the cement paste sets and hardens to a stone mass. The cement used in this experimental investigation is ordinary Portland cement 53 grade. Storage of cement requires extra special care to preserve its quality and fitness for use. To prevent its deterioration, wind, rain etc.

4.0 Test Results

4.1 Partial Replacement Glass Powder for Cement

Table 3: Compressive strength results using glass powder

% of Replacement	**Avg. Compressive Strength**	
	7th day	**28th day**
0	11.03	28.01
5	14.24	31.62
15	16.48	47.11
25	12.14	30.51
35	10.07	24.21
45	9.24	18,43

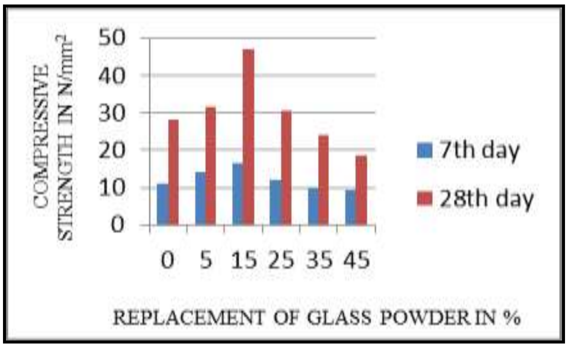

Fig 1: Graph showing compressive strength using glass powder

Table 4: Split tensile strength results using glass powder

% of Replacement	Avg .Split Tensile Strength Forcylinder (N/mm^2)	
	7th day	28th day
0	2.32	3.7
5	2.64	3.94
15	2.84	4.8
25	2.44	3.87
35	2.22	3.44
45	2.13	3

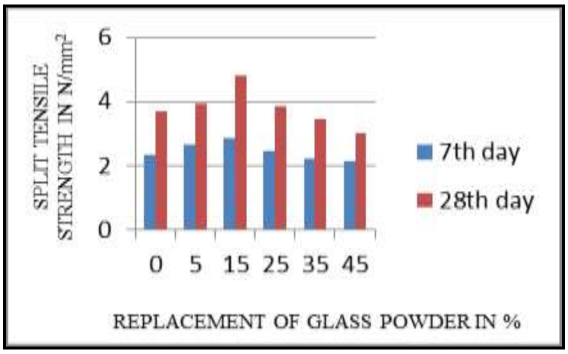

Fig 2: Graph showing split tensile strength using glass powder

Table 5: Flexural strength results using glass powder

% of Replacement	Avg.Flexural Strength for Beam (N/mm^2)	
	7th day	28th day
0	1.32	2.1
5	1.50	2.24
15	1.62	2.74
25	1.39	2.20
35	1.26	1.96
45	1.21	1.71

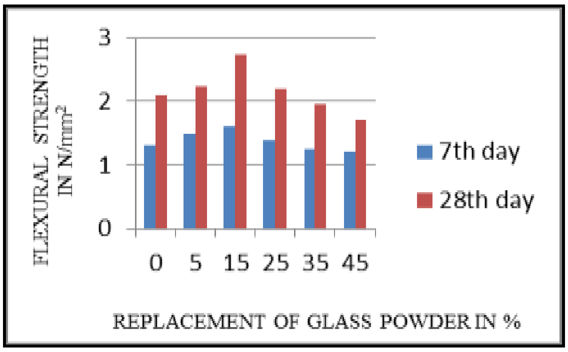

Fig 3: Graph showing flexural strength using glass powder

Table 6: Compressive strength results using ceramic tiles

% of Replacement	**Avg. Compressive Strength**	
	7^{th} day	28^{th} day
0	11.03	28.01
5	24.3	41.6
15	30.8	44.4
25	35.70	45.11
35	27.5	40.8

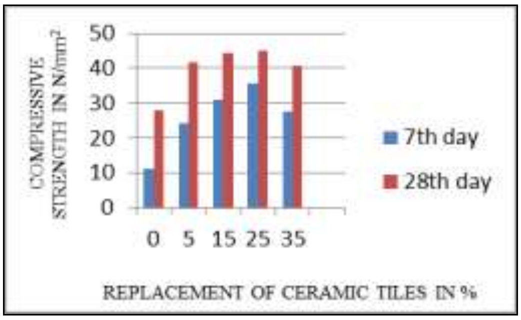

Fig 4: Graph showing compressive strength using ceramic tiles

Table 7: Split tensile strength results using ceramic tiles

% of Replacement	**Avg .Split Tensile Strength for Cylinder (N/mm^2)**	
	7^{th} day	**28^{th} day**
0	2.32	3.7
5	3.45	4.5
15	3.88	4.66
25	4.14	4.70
35	3.98	4.1

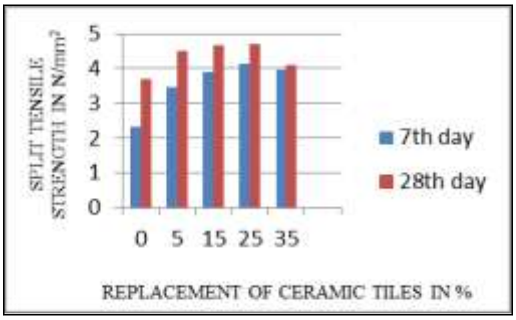

Fig 5: Graph showing split tensile strength using ceramic tiles

Table 8: Flexural strength results using ceramic tiles

% of Replacement	Avg.Flexural Strength for Beam (N/mm^2)	
	7th day	28th day
0	1.32	2.11
5	1.97	2.57
15	2.21	2.66
25	2.3	2.88
35	2.09	2.55

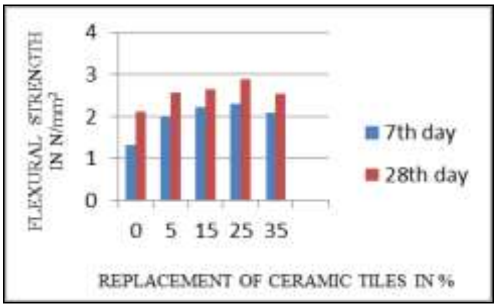

Fig 6: Graph showing flexural strength using ceramic tiles

5.0 Result

In this project, it has been proposed a concrete, by modifying the bulk formulations of the conventional concrete. The coarse aggregate is replaced by same sized ceramic waste and the cement replaced by glass powder.

The following results may be drawn from the study:

- When cement is replaced by 15 % of glass powder replaces, the compressive strength is found to be maximum.
- Regarding the mechanical performance in terms of compressive and tensile strength, the use of ceramic recycled aggregate for concrete is suitable. And the optimum value is found to be 25 %.
- The compressive strength of concrete at 7 and 28 days increases initially as the percentage of replacement of waste glass powder and waste ceramic tiles increases and becomes maximum at a proportion around M35.
- The split tensile strength of concrete at 7 and 28 days increases initially as the percentage of replacement of waste glass powder and waste ceramic tiles increases and becomes maximum at a proportion around M35.
- Optimum replacement level for waste glass powder and waste ceramic tiles in place of ordinary Portland cement and natural coarse aggregate respectively is found to be proportion of M35 from the consideration of strength of concrete.

Table 9: Optimum values for glass powder and ceramic tile waste

Compression strength	36.44 N/mm^2
Split tensile strength	4.22 N/mm^2
Flexural strength	2.4 N/mm^2

6.0 Conclusion

The concrete with the use of waste ceramic tiles and glass powder is found to be economical and environment friendly.

- From the study carried out it is clear that the implementation of concrete is easier and a better option.
- The use of glass powder as a percentage replacement for cement is environment friendly.
- Glass powder instead of being discarded can be used in its complete crushed form can be used for the powder content in the binder.
- They are expected to show better results.
- Due to the reuse of materials considered as waste the economy is being stabilised.
- The main aspect followed in this project is to reduce the waste disposal and save the earth from environmental hazards.

7.0 References

1. R. Idir, M. Cyr, A. Tagnit-Hamou "Use Of Waste Glass As powder and Powder And Aggregate In Cement-Based Materials" 1st International Conference on Sustainable Built Environment Infrastructures in Developing Countries ENSET Oran (Algeria),2009, p.p. 109-114.
2. Dr. G.Vijayakumar, Ms H. Vishaliny, Dr. D. Govindarajulu, "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 2, February 2013.
3. C.D Arun Kumar & K.Sakthimurugan (2013) "Study of waste glass powder as pozzolanic material in concrete", Journal Built Expressions, Vol-2, Issue-5.
4. R.Vanghiyan (2013), "Workability by replacement of cement with waste glass", International Journal of Innovative Research in Science, Engnieering and Technology, Vol-3, Issue-7.
5. Kumarappan N (2013), "compressive strength of glass powder concrete", International Journal of Engnieering Research and Technology ISSN: 2278-0181 Vol-2, Issue- 10.
6. Cesar Medina and sanchez de Rojas M.I. (2012), „Reuse of Sanitary Ceramic Waste as Coarse aggregate in EcoEfficient Concretes‟ ,Cement and Concrete Composites, Issue 34, pp.48-54.

*****