Analysis of Glass Powder as A Partial Replacement of Cement in Concrete

Hosanna. S[1]
Department of Civil Engineering
Parisutham institute of technology and science
Thanjavur

Karthikeyan A R[2]
Department of Civil Engineering
Parisutham institute of technology and science
Thanjavur

Bhuvaneswari. S[3]
Department of Civil Engineering
Parisutham institute of technology and science
Thanjavur

***Abstract*— Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of green house gases, such as CO_2, to the atmosphere. Among the greenhouse gases,CO_2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effectsassociated with cement manufacturing, there is a need to develop alternative binders to make concrete. Consequently extensive research is on going into the use of cement replacements, using many waste materials and industrial byproducts. Efforts have been made in the concrete industry to use waste glass as partial replacement of fine aggregates and cement. In this study, finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. This work examines the possibility of using Glass powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 0%, 25%, 35% and 50% and tested for its compressive, Tensile and flexural strength up to 7 days and 28 days of age and were compared with those of conventional concrete;from the results obtained , it is found that glass powder can be used as cement replacement material.**

I. INTRODUCTION

During the Roman Empire, concrete was made from quick lime, pozzolanic ash/ pozzolana, and an aggregate of furnace. It is widely used in many Roman structures, a key event in the history of architecture termed as Concrete Revolution. It is free Roman construction from the restrictions of stone and brick material and allowed for revolutionary new designs both in terms of structural complexity and dimensions.

The word concrete comes from the Latin word "conretus", (meaning compact or condensed), the past participle of "concresco", from "com"(together) and "cresco" (to grow).

Concrete is the composition of cement, aggregate such as gravel, limestone, or granite, plus a fine aggregate such as sand,admixtures , and water. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used to make pavements, pipe, architectural structures, foundations, motorways / roads, bridges / overpasses, parking structures, brick / block walls and footings for gates, fences and poles.

Concrete is used more than any other man-made material in the world. As of 2006, about cubic kilometers of concrete are made each year—more than one cubic meter for every person on Earth. Concrete powers US $35billion industry, which employs more than two million worker in the United states alone. More than 55,000 miles (89,000km) of highways in the United States are paved with this material. Reinforced concrete and prestressed concrete are the most widely used modern kinds of concrete functional extensions. Recently, the use of recycled materials as concrete ingredients in gaining popularity because of increasingly stringent environmental legislation. The most conspicuous of these ids of Glass powder, a byproduct of waste Glass powder. This has a significant impact by reducing the amount of quarrying and landfill space required, and as it acts as a cement replacements, reduces the amount of cement required to produce a solid concrete. Concrete additives have been used since Roman and Egyptian times, when it was discovered that adding volcanic ash to the mix allowed it to set under water. Similarly, the Romans knew that adding horsehair made concrete less liable to crack while it hardened, adding blood made it more frost-resistant. In modern times, researches have experimented with the addition of other materials to create concrete with improved properties, such as higher strength or electrical conductivity. Combining cement with aggregate and sufficient water makes concrete.

Water allows it to set and bind the materials together. Different mixtures are added to meet specific requirements. Concrete is normally reinforced with the use of rods or steel mesh before it is poured into moulds. Interestingly, the history of concrete finds of concrete evidence in Rome some 2000 years back. Concrete was essentially used in aqueducts and roadways construction in Rome. In 1886, the first rotary kiln was introduced in England that made constant production of cement. In 1891, George Bartholomew made the first concrete street in Ohio, USA. By 1920s, concrete found major usage in construction of roads and buildings. It was in 1936 that the first concrete dams Hoover and Grand cooley were built. There has been no looking back for concrete since its modern development. Known as the strongest building material, concrete has found major uses in dams, highways, buildings and many different kinds of building and

construction. The secret of concrete has lost for 13 centuries until 1756, when the British engineer John Smeaton pioneered the use of hydraulic lime in concrete in the early 1840s. This version of history has been challenged however, as the Cana du Mudi was constructed using concrete in 1670. Concrete additives have been used since Roman and Egyptian times, when it was discovered that adding volcanic ash to the mix allowed it to set under water.
In modern times, researchers have experimented with the addition of other materials to create concrete with improved properties, such as higher strength or electrical conductivity.

II. MATERIALS

A. GLASS POWDER
Waste glass available locally inPondicherry shops is been collected and made into glasspowder. Glass waste is very hard material. Before addingglass powder in the concrete it has to be powdered todesired size. In this studies glass powder ground in ball/pulverizer for a period of 30 to 6o minutes resulted inparticle sizes less than size 150 µm and sieved in 75 µm. Glass powder in concrete improves both the mechanical and durability characteristics of the concrete.

The use of recycled glass as the partial re-placement of cement greatly enhances the aesthetic appeal of the concrete. Recent research findings have shown that concrete made with recycled glass powder have shown better long term strength and better thermal insulation due to its better thermal properties of the glass powder.Glass powder is used to increase strength anddurability of concrete, but generally requires the used for more resistant towards corrosion.

Glass powder is not available in any dry and wet conditions, It has to be produced by collecting the waste glass material and crushed them all with high degree of heat the glass powder will be produced. Glass powder without the dosages of chemical admixtures into it. It emphasized the effect of glass powder on workability level Four levels of glass powder contents (as partial replacement of cement by weight) at 0% , 25%, 35%, and 50% (control mix).

Approximately 100times smaller than the average cement particle.Because of its extreme fineness and high glass content. Glass powder is a highly effective pozzolanic material .

Characteristics and application glass powder consists of fine vitreous particles with a surface area on the order of 215,280 ft^2/lb (20,000 m^2/kg) when measured by nitrogen absorption techniques, with particle approximately one hundredth the size of the average cement particles.

B. GLASS POWDER PRODUCTION
Glass powder it is not the original product it's the By-product produced from the waste glass particles the entire process will be shown in the below map. The map will shows the following areas Waste glass particles collecting area , Hooper , Crusher , Cullet mill , Powder sifter , Powder conveyor , Mixing machine , Batching machine.*

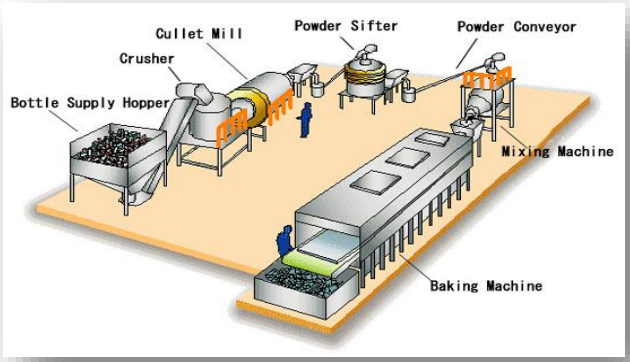

Figure 1. Glass powder Production

completing 12 cycles of stroke on each face of block. Each cycle of stroke was given using vertical wire brush and corresponding percentage of wearing was noted.

III. METHODS

A. *Fineness Modulus Test*
To find the fineness modulus of fine aggregate and The Standard grain size analysis test determines the relative proportions of different grain sizes as they are distributed among certain size ranges.

S.NO.	PHYSICAL PROPERTIES	VALUES
1.	Specific gravity	2.6
2.	Fineness passing 150mm	99.5
3.	Fineness passing 90mm	98

S.NO.	CHEMICAL PROPERTIES	VALUES
1.	PH	10.25
2.	Colour	Grayish white

S.NO.	CHEMICAL COMPOSITIONS OF GLASS POWDER	% BY MASS
01.	Si02	67.330
02.	Al203	2.620
03.	Fe203	1.420
04.	Ti02	0.157
05.	CaO	12.450
06.	Mgo	2.378
07.	Na20	12.050

IV. RESULTS AND DISCUSSION

4.1. TEST RESULTS AND GRAPH
Size of casted cube : 150mm x 150mm x 150mm
Coarse aggregate : pass through 20mm and retain at 16mm
Fine aggregate : pass through 2.36mm and retain at 1.86mm
Water : potable

Table. 2. Ultimate load for 7 days cubes

Replacement of cement	Ultimate load(KN)		
	7days model 1.	7days model 2.	7 days model 3.
0%	780	780	760
25%	800	620	650
35%	470	400	450
50%	280	150	230

Table. 3. Ultimate load for 28 days cubes

Replacement of cement	Ultimate load(KN)		
	28days model 1.	28days model 2.	28 days model 3.
0%	690	920	750
25%	740	540	600
35%	500	490	480
50%	350	310	340

Table. 4. Compressive strength for 7 days cubes

Replacement of cement	Compressive strength for 7 days cube
0%	34.66
25%	35.55
35%	20.88
50%	12.44

Table. 5. Compressive strength for 28 days cubes

Replacement of cement	Compressive strength for 28 days cube
0%	30.66
25%	32.88
35%	22.22
50%	15.55

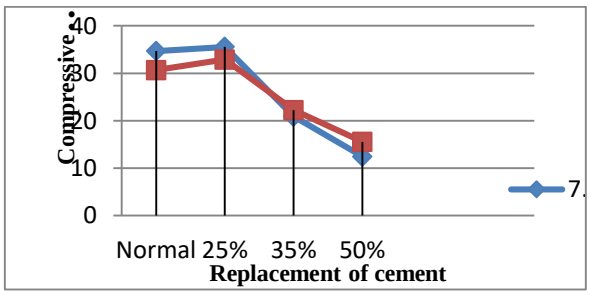

Fig. 4.2 Graph for M20 cube

- The above graph shows the compressive strength for M20 grade of 7 days ans 28 days cube
- This graph represents the 25% replacement of glass powder in concrete gives the maximum compressive strength
- The other similar percentages of 35% and 50% shows the lesser value when compared to the compressive strength of 25%
- The maximum compressive strength of 25% replacement value is 35.55 kN / mm^2

Size of casted cylinder : Dia-150mm , Depth – 300mm.
Coarse aggregate : pass through 20mm and retain at 16mm
Fine aggregate : pass through 2.36mm and retain at 1.86mm
Water : potable

Table. 6. Ultimate load 7 days cylinders

Replacement of cement	Ultimate load(KN)		
	7days model 1.	7days model 2.	7 days model 3.
0%	180	180	180
25%	220	130	150
35%	80	100	90
50%	40	50	45

Table. 7. Ultimate load 28 days cylinders

Replacement of cement	Ultimate load(KN)		
	28days model 1	28days model 2	28 days model 3
0%	200	210	200
25%	220	160	180
35%	120	100	110
50%	30	50	40

Table. 8. Split tensile strength for 7 days cylinders

Replacement of cement	Split tensile strength for 7 days cube
0%	4.00
25%	4.44
35%	2.22
50%	1.11

Table. 9. Split tensile strength for 28 days cylinders

Replacement of cement	Split tensile strength for 28 days cube
0%	4.66
25%	4.88
35%	2.66
50%	1.11

Fig. 4.2 Graph for M20 cylinders

- The above graph shows the Split tensile strength for M20 grade of 7 days and 28 days cylinders.

B. This graph also represents the 25%Grade of Concrete

Size of casted cubes: 150mm x150mm x 150mm
Grade of concrete: M20.

Table. 1. Details of Specimen

Grade	Curing days	Normal	25%	35%	50%
M20	7 days	3	3	3	3
	28days	3	3	3	3

Total number of cubes for M20 grade concrete = 16 cubes

Total number of cylinders for M20 grade concrete = 08 cylinders

.

6. Ultimate load 7 days cylinders

Replacement of cement	Ultimate load(KN)		
	7days model 1.	7days model 2.	7 days model 3.
0%	180	180	180
25%	220	130	150
35%	80	100	90
50%	40	50	45

Table. 7. Ultimate load 28 days cylinders

Replacement of cement	Ultimate load(KN)		
	28days model 1	28days model 2	28 days model 3
0%	200	210	200
25%	220	160	180
35%	120	100	110
50%	30	50	40

Table. 8. Split tensile strength for 7 days cylinders

Replacement of cement	Split tensile strength for 7 days cube
0%	4.00
25%	4.44
35%	2.22
50%	1.11

Table. 9. Split tensile strength for 28 days cylinders

Replacement of cement	Split tensile strength for 28 days cube
0%	4.66
25%	4.88
35%	2.66
50%	1.11

Fig. 4.2 Graph for M20 cylinders

- The above graph shows the Split tensile strength for M20 grade of 7 days and 28 days cylinders
- This graph also represents the 25% replacement of glass powder in concrete gives the maximum Split tensile strength
- The other similar percentages of 35% and 50% shows the lesser value when compared to the Split tensile strength of 25%
- The maximum Split tensile strength of 25% replacement value is 4.4kN/mm^2
-

V. CONCLUSION

- By using the glass powder in concrete will reduce the green house effect produced by the cement manufacturing industry
- Glass powder concrete increases the compressive, tensile and flexural strength effectively, when compared with conventional concrete.
- Cement replacement up to 25% with Glass powder leads to increase in compressive strength, Split tensile strength,M20 grade. Beyond 25% there is a decrease in compressive strength and Split tensile strength for 28 and 7days curing period.
- It is observed that the compressive strength and Split tensile strength of M20 grade concrete is decreased by 35%, and 50% respectively.
- There is a decrease in workability as the replacement level increases, and hence water consumption will be more for higher replacements.
- The maximum replacement level of Glass powder is 25% for M20 grade of concrete.

REFERENCE

[1] Aimin Xu and Ahmad shayam, “Value – added utilization of waste glass in concrete”, Cement and concrete research, vol.34,81-89,2004.

[2] Carpenter,A.J. and Cramer,C.M, “ Mitigation of ASR in pavement patch concrete that incorporates highly reactive fine aggregate”,Transportation Research Record 1668, Paper No. 99-1087,pp.60- 67,1999.

[3] Chi sing lam, chi sun poon and Dixon chan, “ Enhancing theperformance of pre – cast concrete blocks by incorporating wasteglass – ASR consideration”, Cement and concrete composites, vol:29 pp, 616-625,2007.

[4] Christopher cheeseman, " Production of sintered light weight aggregate using waste ash and other industrial residues", Belgium, 2011.
[5] Federio.L.M and Chidiac S.E, " Waste glass as a supplementary cementitious material in concrete – Critical review of treatment methods", Cement and Concrtet Composites, vol,31,606-610,2001.
[6] Idir.R,Cyr.M and Tagnit – Hamou.A, " Use ofwasteglass as powderand aggregate in cement based materials", SBEIDCO – 1stinternational Conference on Sustainable Built EnvironmentInfrastructures in Developing Countries ENSET Oran (Algeria) –October 12-14, 2009.
[7] IIker bekir topcu and mehmet canbaz, " Propertiesofconcrete withglass ", Cement and Concrete Research, vol:34,267-274,2004.
[8] Jin.W, Meyer.C, and Baxter.S, "Glasscrete – Concrete with glass aggregates", ACI Materials Journal, vol. 97.pp. 208-213, 2000.
[9] Mageswari.L.M and B.Vidivelli, " The use of SheetGlass Powder asFine Aggregate Replacement in Concrete", the open CivilEngineering Journal, vol:4,65-71, 2010.
[10] Malek Batayneh, Iqbal Marie, Ibrahim Asi, " Use of Selected wasteMaterials in Concrete Mixes", Waste Management, vol. 27, 2007.
[11] C.Meyer, S.Baxter and W.Jin, " alkali – Aggregate Reaction in Concrete with waste Glass as Aggregate", Proceedings of the 4th Materials Engineering Conference : Materials for the new millennium, ASCE, Reston, V.A,pp.1388-1397, 1996.
[12] Narayanan Neithalath, " An overview of the benefits of using glasspowder as a partial cement replacement material in concrete", TheIndian concrete journal, 9-18, 2011.
[13] Narayanan Neithalath and Nathan Schwarz, " Properties of Cast – in– Place Concrete and Precast Concrete Blocks Incorporating Waste Glass Powder", The open Construction and Building Technology Journal, vol:3,42-51, 2009.
[14] Pereira de Oliveira. L.A, J.P. castro – Gomes, P.Santos, "Mechanical and Durability Properties of concrete with Ground waste Glass Sand", International conference on durability of Building Materials and components, Turkey, 2008.
[15] Samtur.H.R," Glass Recycling and Reuse," universityof Wisconsin,Madison Institute for Environmental Studies, Report No.17, March 1974.
[16] Seung Bum Park and Bong-Chum Lee, " studies onexpansion properties in mortar containing waste glass and fibers", Cement andconcrete Research, vol:34,1145-1152, 2004.