Experimental investigation on cement with waste glass powder in pervious concrete

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Abstract— Pervious concrete (no fine concrete) is a concrete containing little or no fine aggregate, it consists of course aggregate and cement paste. It seems pervious concrete would be a natural choice for use in structural appilications in this age of 'green buliding'. It consumes less raw material than the normal concrete (no sand), it provides superior insulation values when used in walls, and through the direct drainage of rainwater, it helps recharge groundwater in pavement appilcations.

This project discuss about the pervious concrete in which the cement is partially replaced by the waste glass powder. Glass powder is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. Waste glass locally available and it has been collected and made into glass powder. The materials and possible mix proportions, properties such as compressive strength, flexural strength, shrinkage, and permeability with initial tests are done.

Index Terms— Compressive strength, Flexural strength, Glass powder, low cost, opc cement, Pervious concrete, water cement ratio.

1 INTRODUCTION

Pervious concrete is a unique and effective solution to reduce the runoff from paved areas and recharging the ground water. Pervious concrete can uproot storm water more rapidly than conventional concrete. It is directly recharging the ground water so it eliminates the need of retention pond, swales and storm water management devices. It is also eliminate costly storm water detention vaults and piping systems. Thus reduce construction expenses, safety issues and maintenance cost. The waste management problem has already become severe in the world. The problem is compounded by the rapidly increasing amounts of industrial wastes of a complex nature and composition. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for building materials like cement, the importance of using industrial waste cannot be underestimated. Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability. Therefore, the main objective of this study is to use waste glass powder materials to develop a pervious concrete mixture proportion and to improve the compressive strength and flexural strength of pervious concrete. Before adding glass powder in the concrete it has to be powdered to required size.

In this research study the (OPC) cement has been replaced by glass waste powder accordingly in the range of 10% and 20% by weight of cement for 0.35 water/ cement ratio. The compressive strength test and flexural strength test was carried out for 7, 14 and 28 days to measure the compressive strength and flexural strength of concrete. So the aim of the investigation is to study the behavior of pervious concrete while replacing the waste glass powder with different proportions in concrete. Test results have reflected, the compressive strength and flexural strength achieved up to 20% replacement of cement with waste glass powder will be optimum without effecting properties of fresh and hardened concrete.

2 OBJECTIVE

The main objective of this investigation is to develop a strong and durable pervious cement concrete (PCC) mix using different types of fine aggregates with varying the quantity of fine aggregates. In addition, it is also aimed to compare the properties of these PCC mixes. In the present investigation, two types of fine aggregates are used viz., Crushed Stone (CS) and River Sand (RS) are used. The percentage of fine aggregates used in PCC mix is 15 per cent. The properties of PCC mixes investigated are compressive strength, flexural strength, abrasion resistance, permeability, and clogging potential. The objectives of the work would be:

(i) To determine the durability, properties of permeable concrete.

(ii) To determine the impact resistant of permeable concrete pavement.

(iii) To compare the properties of permeable con-

crete with the existing concrete pavement.

3 ADVANTAGES OF PERVIOUS CONCRETE

1. Water budget retention and pollution removal
2. Less need for storm sewer
3. Green building alternative suitable for many application
4. Natural run-off allows rainwater to drain directly to sub-base
5. Reduced construction requirements for drainage structures
6. Reduced pollution prevents environmental damage
7. Protects streams and lakes and allows local vegetation to thrive

4 MATERIALS REQUIRED

Waste Glass Powder

Waste Glass Powder is produced from locally available glass industry. Before adding glass powder in the concrete it has to be powdered to desired size. Chemical properties of Waste Glass Powder is given in Table 1 and physical properties of glass powder is given in Table 2.

Table 1:
Chemical Properties of Waste Glass Powder

Sl No.	Particulars	Proportion
1.	Silicon Dioxide (SiO_2)	66.56 %
2.	Aluminum oxide (Al_2O_3)	01.02 %
3.	Potassium Oxide (K_2O)	01.06%
4.	Calcium Oxide (CaO)	11.50 %
5.	Magnesium Oxide (MgO)	03.02 %
6.	Sodium Oxide (Na_2O)	12.32 %
7.	Boron Trioxide (B_2O_3)	02.45 %

Table 2: Physical Property of Waste Glass Powder

Cement

The Ordinary Portland Cement of 53 grade

sl.no	particular	properties
1	Colour	White
2	Specific gravity	90 microns
3	Partical size	2.5

Hathi Cement conforming to IS: 12269 - 1987 is been used. Physical property and chemical composition of cement is as per Table 3 and Table 4.

Table 3:

Physical Properties of Ordinary Portland Cement

properties	Value of cement	IS CODE : 12269 - 1987
Specific Gravity	3.15	3.10-3.15
Consistency	28%	30-35(%)
Initial setting time	35 min	30 minimum minutes
Final setting time	178 min	600 maximum minutes

Table 4:
Chemical Compositions of Ordinary Portland Cement 53 Grade (OPC)

Sl .No.	Particulars	Proportion
1.	Silicon Dioxide (SiO_2)	21.77 %
2.	Aluminum oxide (Al_2O_3)	2.59 %
3.	Sulphur Trioxide (SO_3)	02.41%
4.	Calcium Oxide (CaO)	57.02 %
5.	Magnesium Oxide (MgO)	02.71 %
6.	Ferric Oxide (Fe_2O_3)	0.65 %

Aggregate

Aggregate occupies most of the volume of the concrete show they are the important constituents of concrete. They give body to the concrete, reduce shrinkage and effect economy.

Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

3 MIX DESIGN

The mix proportion by using glass waste powder. For the design mix aggregate content is 1500 kg/ m3 and Cement: Aggregate ratio 1:4 is kept constant.

Table 6:
Mix proportion of concrete using glass powder for 1m^3

mix	Aggregate content	Cement content	W/C ratio	Cementious material
M0.35	1500	375	0.35	0%
Mix-1		337.5		10%
Mix-2		300		20%

Table 7:
Design Mix using glass powder

Concrete Design Mix Proportions (kg/m3)					
Mix	W/C ratio	Quantity required			
		Cement	Aggregate	Glass powder	water
M0.35	0.35	375	1500	0	131.5
Mix-1		337.5		37.5	
Mix-2		300		75	

4 EXPERIMENTAL PROCEDURE

The evaluation of glass waste for use as a replacement of cement material begins with the concrete testing. Pervious concrete contains cement, water, coarse aggregate and glass waste. In pervious concrete 10% and 20% of the cement is replaced with glass waste. Three cube samples were cast on the mould of size 150*150*150 mm for each concrete mix with partial replacement of cement with a w/ c ratio of 0.35. Three beam samples were cast on the mould of size 100*100*500 mm for each concrete mix with partial replacement of cement with a w/ c ratio of 0.35. After about 24 hr the specimens were demoulded and water curing was continued till the respective specimens were tested after 7, 14 and 28 days for compressive strength test and flexural strength test.

Compressive Strength (IS: 516 – 1959):

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The comparative studies were made on each concrete mix for 0.35. W/ C ratio of partial replacement of cement with glass waste as 10% and 20%.

Flexural Strength (IS: 516 – 1959):

Flexural strength tests were performed on flexural testing machine using beam samples. Three samples per batch were tested with the average strength values reported in this paper. The flexural studies were made on each concrete mix for 0.35. W/ C ratio of partial replacement of cement with glass waste as 10% and 20%.

Table 8:
Comperssive Strength of Cube (150×150×150) at 7, 14, 28 days.

Concret mix	W/C ratio	% of Replaceplacement Of cement	Average compressive strength		
			7 days	14 days	28 days
$M_{0.35}$	0.35	0%	07.13	08.30	9.42
Mix-1		10%	09.21	10.40	11.68
Mix-2		20%	10.21	11.51	12.73

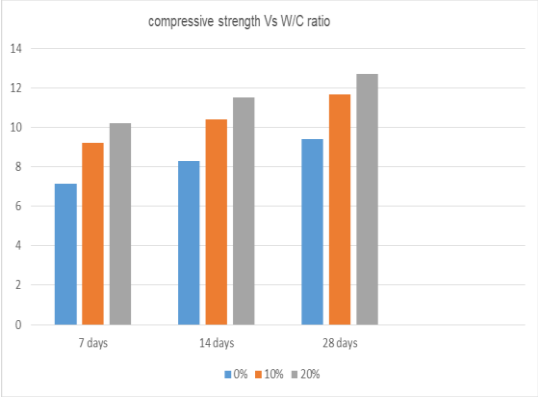
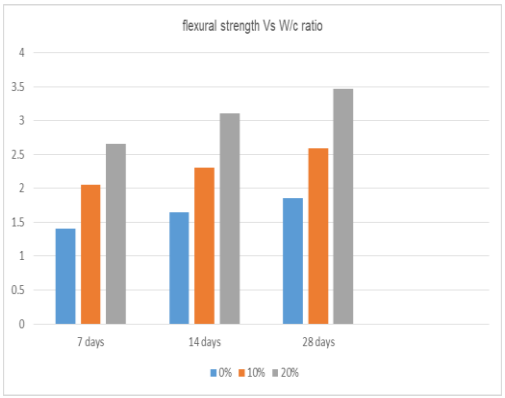


Table 9:

Flexural Strength of Beams (100x100x500) at 7, 14 and 28 Days

Concret mix	W/C ratio	% of Replace-placement Of cement	Average flexural strength		
			7 day	14 day	28 day
$M_{0.35}$	0.35	0%	1.40	1.65	1.85
M-1		10%	2.05	2.30	2.59
M-2		20%	2.65	3.10	3.47



5 CONCLUSION

Based on experimental investigations concerning the compressive strength and flexural strength of concrete, the following observations are made:

[1] W/ C ratio is increase respectively compressive strength and flexural strength of pervious concrete is increase.

[2] The Compressive Strength of Pervious Concrete is increases when the replacement of Cement with Glass Powder up to 20% replaces by weight of Cement.

[3] The Flexural Strength of Pervious Concrete is increases when the replacement of Cement with Glass Powder up to 20% replaces by weight of Cement.

6 FUTURE SCOPES

We can use 25 mm aggregate size for future study or analysis. Pervious concrete is a special type of concrete with a high porosity used for concrete pavement applications that allows water from precipitation and other sources to pass directly through it, thereby reducing the runoff from a site and allowing groundwater recharge

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