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Pervious concrete with cupola slag

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Abstract- Nowadays waste materials are used in the conventional concrete. In the present work the waste material cupola slag which is a by-product of cast iron manufacturing used for the preparation of Pervious concrete. Concrete made from cupola slag as partial replacement of cement will be studied for workability, compressive strength, permeability. We will use Cupola Slag as partial replacement of cement by different percentage. The percentage replacement of Cupola Slag will be 15%, 25%, 35% with cement. We will prepare cubes, finally slump test, compressive strength test, will be conducted to obtain the necessary results. A large no. of trial mixes are required to select the desired optimum replacement of cement by waste material Cupola Slag.

Keywords- Pervious concrete, cupola slag, partial replacement, optimum value.

1. INTRODUCTION

Day by day the groundwater level decreases due to the excess use of water by high class society, so there is a major problem created due to this issue.With the need of present infrastructure development, the conventional road pavements are increased which increases soil erosion, pollution, runoff of water. Pervious concrete helps in decreasing the stormwater runoff, soil erosion. Pervious concrete is an eco friendly pavement. Pervious concrete is mixture of cement, coarse aggregate and water. Being a void contained pavement, pervious concrete does not give more strength, so it is used in parking areas, footpaths, internal roads joining one or two buildings or campus roads The textured surface is especially beneficial during the most difficult and dangerous of driving conditions, such as in rain and snow. In other words, pervious concrete helps in protecting the surface of the pavement and its environment. With the increasing demands of the materials, waste products also increase, to dump them, useful land is wasted for dumping these waste products. So, we use cupola slag waste products to increase the strength of the pervious pavement by partial replacement of cement.

Cupola slag is a by-product obtained from cast iron and pig iron manufacturing process. This too have similar properties as cement. Cupola slag is used in the form of granulated slag for concrete production (Baricova et. al., 2010; D. A. Aderibigbe et. al., 1982)This is because it is only in its use for concrete production that its pozzolanic or hydraulic property can be utilized and this means use of less Portland cement. Partial replacement of cement with cupola slag is done by weight in percentages 15%, 25%, 35%, 45%.

1.2 Objectives

1. To study the influence of cupola slag on strength of pervious concrete.
2. To achieve the target strength of pervious concrete using mix design.
3. To analyze the variations in the infiltration rate & storm water runoff.

1.3 Applications

1. Pervious concrete can be used for residential roads and driveways. It can be applied for sidewalks and pathways.
2. Pervious concrete can also be used for parking areas.
3. On tennis courts pervious pavements can be used.
4. It can also be used for slope stabilization. Pervious concrete can also be applied for Pavement edge drains,
5. Noise Barriers

2. LITERATURE REVIEW

D.A. Aderibigbe et. al. (1982)[1], obtained similar properties of Cupola slag and cement in a mortar. This paper shows us the cement and cupola on partial

replacement of slag has the same properties. The results of studies on the pozzolanic properties of cupola slag and its effect cement in a mortar have been presented.

M. Harshavarthana Balaji et. al. (2010)[2], designed pervious concrete using SILICA FUME to increase its strength. They have designed the pervious concrete using the ACI-522R-06.

D. Baricová a et. al. (2010)[3], compared blast furnace slag with cupola slag depending upon their mechanical properties and compositions**.** The paper presents results from the research of the blast furnace and cupola furnace slag utilization in the concrete production.

A.V. Pradeepa et. al. (2014)[4], obtained experimentally that the mechanical properties were enhanced when GGBF Slag is reinforced with the Glass fiber polymer and also the specimen having 15% (largest constituent of GGBF Slag percent among all other specimens) possesses better Tensile Strength, Compression Strength, Flexural Strength, Impact strength and Hardness.

3. EXPERIMENTAL MATERIAL AND EQUIPMENT

3.1 Materials

Cement– Ordinary Portland cement, 53 Grade conforming to IS: 269 – 1976. It will be used for casting all the specimens. The compressive strength measured in standard mortar at 28 days was 54MPa. The physical properties are conforming to IS 12269-1987. The choice of brand and type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used.

Aggregate- Locally available crushed blue granite stones conforming to graded aggregate of nominal size 14 mm- 20 mm as per IS: 383 – 1970. The specific gravity was 2.7 and retained on 13.2mm sieve and passing through 16mm.Several investigation concluded that as the aggregate size increase compressive strength of the mix decreases. Bulk density of aggregate is 1737 Kg/m^3

Water – To mix the ingredients of concrete tap water has been used in this thesis.

Cupola Slag – Cupola slag is a by- product of cast iron manufacturing is produced during the separation of the molten steel from impurities in cupola furnaces.
Cupola slag obtained from Prajapati Foundries, Pune. They are using this material for the purpose of land filling. The slag was dumped in a large lump form. It was first dusted and isolated to remove the earth impurities. It was then crushed to sizes less than 40mm with the use of UTM. Then ball mill was used to achieve the powdered granulated form of the slag. It was sieved through the 150 µm and was finally sieved through 90µm in order to get a particle size similar to the Portland cement particle size.

3.2 Equipments

Ball Mill – A ball mill is a type of grinder used to grind and blend materials. It works on the principle of impact and attrition: size reduction is done by impacts as the ball drop from near the top of the shell. The grinding media is the ball which is made up of steel.

Universal Testing Machine – UTM is used to test the compressive strength and tensile strength of materials. The "universal" part of the name reflects that it can perform many standard compression and tensile strength on material, component and structures.

Mould- Cubical Mould of size 150 X 150 X 150mm is used in this thesis.

Steel tamping rod – 16mm diameter of tamping rods are used for the compaction.

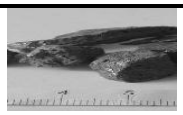
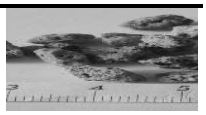
Curing – Using Jute bags. To prevent the top surface of the pervious concrete from drying we used Jute bags.

4. SELECTION OF MATERIAL

4.1 Comparison between cupola slag and blast furnace slag

It helps to select the material by comparing composition of it.

	CUPOLA SLAG	BLAST FURNACE SLAG

	It originates from melting of gauge parts of metal.	It originates from melting of gangue parts of metal.
SIZE	obtained in lump sizes	typically with sand to gravel size particle
FEO %	1-15	0.4 – 1.1
CAO%	20-50	36-50
SiO_2 %	25-55	30-42
Al_2O_3 %	5-20	7-18
BASICITY	ranges from acidic to basic slag	acid slag
STRENGTH PROPERTIES	depends on size of particles and composition	depends on size of particles and composition
ABRASION RESISTANCE	depends on size of particles and composition	depends on size of particles and composition
		

Based on the comparison above of cupola and blast furnace slag, cupola is the material selected as it shows more similar properties as cement have. Blast furnace slag was used before so used here to compare with cupola.

5. MIX DESIGN

Based on ACI 522R-10

Pervious concrete of strength 20 MPa

Design average cube strength at 28 days

20/0.75 = 26.66 N/mm^2

Bulk Density of aggregate – 1737 Kg/m^3

Water-cement ratio- 0.38

b/b_o – 0.99 (table 6.1)

Dry weight of aggregate – 52.75Kg

% void – 15%

% paste – 27%

Cement Content – 11.8Kg

Water content – 5 liter

Replacement of cupola slag – 15 %, 25%, 35% by weight.

6. RESULTS

6.1 Compressive strength

6.1.1 Cupola Slag (15% replacement)

	Strength (Mpa)	Strength (Mpa)	Strength (Mpa)
	7 Days	14Days	28Days
Cube 1	8.32	14.42	19.20
Cube 2	9.40	13.11	18.97
Cube 3	9.10	14.39	19.78

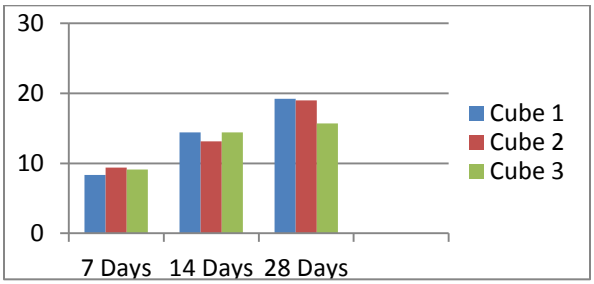


Chart 6.1.1 (15% replacement)

6.1.2 Cupola Slag (25% replacement)

	Strength (Mpa)	Strength (Mpa)	Strength (Mpa)
	7 Days	14Days	28Days
Cube 1	7.02	11.42	15.02
Cube 2	8.06	13.11	16.57
Cube 3	8.72	14.39	15.67

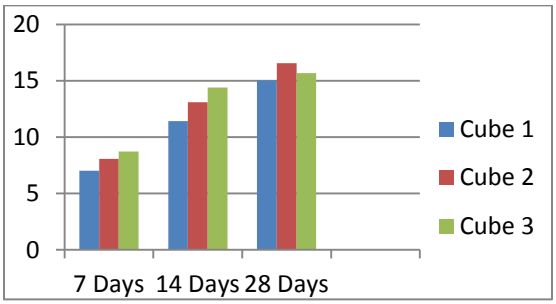


Chart 6.1.2 (25% Cupola Slag)

6.1.3 Cupola Slag (35% replacement)

	Strength (Mpa)	Strength (Mpa)	Strength (Mpa)
	7 Days	14Days	28Days
Cube 1	8.02	11.42	16.95
Cube 2	7.52	13.11	15.75
Cube 3	7.4	14.39	15.30

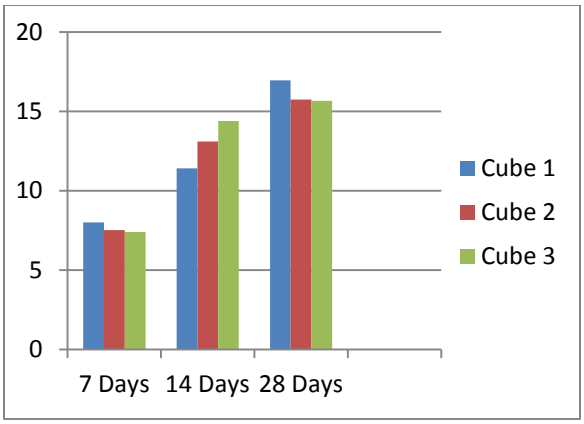


Chart 6.1.3 (35% replacement)

7. CONCLUSION

On the basis of above results the following conclusions can be made:

1. In this mix design, 15% of cement can be replaced by cupola slag which helps to increase the compressive strength of pervious concrete.
2. As the percentage of replacement increases beyond 20% compressive strength decreases.

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