EXPERIMENTAL STUDY ON POROUS CONCRETE

Indhu.P[1], Kavitha.G[2], Gayathiri.D[3], Saleema begum.R[4], Muthu kumar.K[5]
[1]Student, CivilEngineering, Prathyusha Engineering College, India
[2]Student, CivilEngineering, Prathyusha Engineering College, India
[3]Student, CivilEngineering, Prathyusha Engineering College, India
Asst.Professer, Civil Engineering, Prathyusha Engineering College, India
Asst.Professer, Civil Engineering, Prathyusha Engineering College, India

Abstract: Porous concrete is the special type of concrete with high porosity used for concrete flatwork applications that allow water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing ground water recharge. This porosity is attained by a highly inter connected void content. Typically, porous concrete has little or fine aggregate and has just enough cementing paste to coat the course aggregate particles while preserving the interconnectivity of the voids. Porous concrete is an important application for the sustainable construction and one ofmany low impact development techniques used by builders to protect water quality.
***Index terms: High Porosity, No Fine Aggregate, Runoff, Sustainable Construction*.**

I.INTRODUCTION

This provides not only the useful hardened properties, but also results in a mix requiring different considerations in mixing design, mixing procedures, placing, compacting, and curing. Porous concrete as one of concrete family have the same compositions as conventional concrete consisting of cement, water, and aggregate, with the exceptions that the fine aggregate typically is reduced or even omitted entirely, and the size distribution of course aggregate is kept narrow grading. Despite of having a lower strength, the porous concrete with a higher porosity is useful for many applications, such as permeable pavement, purifying water, heat reducer, and sound absorber. Pervious Concrete is a special type of concrete in which no fine aggregates are used and gravel has been used in place of the coarse aggregate. Pervious Concrete is a homogeneous mixture of cement, aggregate / gravel and water. Pervious Concrete is also called as “no-fines” concrete. Cylinders of size 100 mm diameter and 200 mm height are made for an experimental investigation of Water Absorption and Durability of Pervious Concrete. Concrete Durability is one of the most important considerations in the design of new structures and when assessing the condition of existing structures. Concrete construction is becoming increasingly complex and the importance of producing structures that are both cost effective and durable has never been higher. The main purpose of durability is about minimizing the rate of deterioration. Durability of Concrete is related to the design process, specification of materials, workmanship, environmental effects, accidents and repairs. In Water Absorption Test cylinders are cured in curing pond for 28 days and weighing it & % water absorption is to be determined. In Durability Test cylinders are first cured in curing pond for 28 days. Pervious concrete is an alternative that can help to enter a new era in the field of construction. This construction material has characteristic that can be penetrated by water, because of its concrete pores. It can be used as a means of soil water absorption so it can reduce surface runoff and add the groundwater reserves. The use of substitute materials is still not popular in Indonesia. Maybe, this is because of the coarse and fine aggregate materials are easily obtained, but sooner or later these materials will be depleted so the price of these materials from year to year will be more expensive. The volume of coarse aggregate in concrete mixture reaches 78 % and coarse aggregate is the main filler in concrete mixture.

II. MATERIAL REQUIRED:

CEMENT: Cement must develop the appropriate strength. It must represent the appropriate rheological behavior. Generally same types of cements have quite different rheological and strength characteristics, particularly when used in combination with admixtures and supplementary cementing materials.

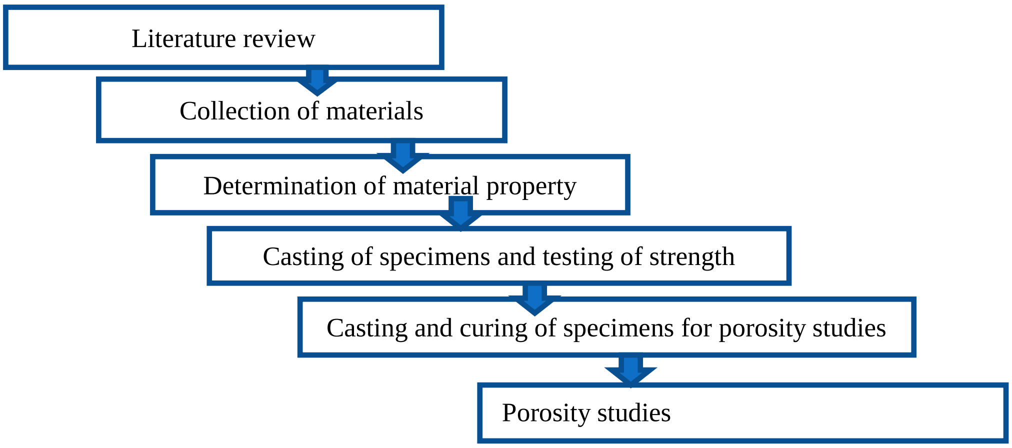
COARSE AGGREGATE: As coarse aggregates in concrete occupy 35 to 70% of the volume of the concrete. It may be proper to categories the properties into two groups: exterior features (maximum size, particle shape, textures) and interior quality (strength, density, porosity, hardness, elastic modulus, chemical mineral composition etc.). Smaller sized aggregates produce higher concrete strength. Particle shape and texture affect the workability of fresh concrete. The transition zone between cement paste and coarse aggregates, rather than the properties of the coarse aggregates itself. Usually an aggregate with specific gravity more than 2.55 and absorption less than 1.5% (except for light weight aggregates) can be regarded as being of good quality. Where aggregates strength is higher, concrete strength is also higher.

THERMAL BEADS: Expanded polystyrene (EPS) is a rigid and tough, closed-cell foam. It is usually white and made of pre-expanded polystyrene beads. The EPS beads are the expanded form of polystyrene granules which are produced indigenously and are available commercially as hard translucent glass-beads with diameter ranging from 0.6 to 2.5 mm.

SILICA FUME: Silica fume, also known as micro silica, (CAS number 69012-64-2and EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolanic material for high-performance concrete.

GROUND GRANULATED BLAST FURNACE SLAG: Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Silica fume is very fine non- crystalline silica, produced in electric arc furnaces, as a by-product of the production of elemental silicon or alloys containing silicon also known as condensed silica fume or micro silica. It is mainly amorphous silica with high SiO_2 content, extremely small particle size and large surface area, highly reactive pozzolan used to improve mortar and concrete.

III. METHODOLOGY



IV. OBJECTIVE

- To determine the effect of material proportions (thermal beads 20% as replacement for coarse aggregate, blast furnace slag 25% and silica fume 15% as replacement for cement) on the engineering properties of the porous concrete.
- To observe the water passing rate through the porous concrete.
- To observe the time taken for total drainage.

SCOPE:

- It has been found porous concrete which is also known as no fines, pervious, gap, graded, and permeable concrete has enhanced porosity.
- Design of conventional M25 concrete mix.
- Replacement of coarse aggregate with suitable proportions of blast furnace slag, silica fume and thermal beads.
- Casting, curing and testing of cube, cylinder and prisms specimens.
- Casting and curing of 300x300x25mm porous concrete specimens.
- Porosity studies on porous concrete specimens.

V. TEST SPECIMEN PREPARATION

Mixing

The procedure for mixing the concrete material is that first the materials are taken with the correct proportion calculated from the mix design. The partial replacement materials are also taken with the proper ratio. After collecting the materials, first mix the cement and silica fume, blast furnace slag without any lumps added then, mix these three in a proper manner. After the complete mix of these three materials, the coarse aggregate are added and mixed properly. All the materials are properly mixed then the water is added into it and mix it thoroughly without any lumps with the proper workability condition.

Casting

When the concrete mixing is done simultaneously the mould is prepared i.e. fixing of bolds and nut, oiling the mould, etc., then the mixed concrete is poured in the prepared mould. After pouring the concrete, it can be split into three layer when pour it for proper compaction using the tamping rod.

Curing

The specimens were remolded after 24 hours and placed it in a curing tank for the specified days i.e. for 7 days and 28 days to attain the strength of the concrete. After the curing is completed, the specimen is tested as 7^{th} day test and 28^{th} day test respectively.

VI. TEST ON POROUS CONCRETE

Compressive strength of concrete

Compressive strength is defined as resistance of concrete to axial loading. The compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000kN.Cubes were placed in Universal Testing Machine (U.T.M), and load was applied. The readings on dial gauge were recorded and compressive strength was calculated. The test was conducted on 150mm cube specimens at 7 and 28 days. The results of Compressive strength are shown in Table7.2.

Calculations: Compressive Strength = Maximum load/Cross Sectional Area

= P/A

FIG. 1 COMPRESSIVE TEST ON CONVENTIONAL CONCRETE

TABLE NO:1 COMPRESSIVE STRENGTH FOR CONCRETE

CURING PERIOD	MIX RATIO	AREA OF SPECIMEN MM^2	MAXIMUM LOAD KN	COMPRESSIVE STRENGTH N/MM^2	AVERAGE COMPRESSIVE STRENGTH KN/MM^2
7 days	Normal mix proportion	150x150	460	20.44	20.5
7 days		150x150	464	20.66	
28 days		150x150	520	23.11	23.06
28 days		150x150	518	23.02	

TABLE NO.2 COMPRESSIVE STRENGTH FOR POROUS CONCRETE WITH PARTIAL REPLACEMENT OF 15% SILICA FUME AND 20% GGBS

CURING PERIOD	MIX RATIO	AREA OF SPECIMEN MM^2	MAXIMUM LOAD KN	COMPRESSIVE STRENGTH KN/MM^2	AVERAGE COMPRESSIVE STRENGTH KN/MM^2
7 days	Concrete with partial replacement of 20% Silica fume and 25% ggbs	150x150	140	6.2	6.4
7 days		150x150	150	6.6	
28 days		150x150	250	11.11	11.2
28 days		150x150	256	11.37	

FIG 2. **COMPRESSIVE TEST ON POROUS CONCRETE**

TABLE NO.3 COMPRESSIVE STRENGTH FOR POROUS CONCRETE WITH PARTIAL REPLACEMENT OF 20% SILICA FUME AND 25% GGBS

CURING PERIOD	MIX RATIO	AREA OF SPECIMEN MM^2	MAXIMUM LOAD KN	COMPRESSIVE STRENGTH KN/MM^2	AVERAGE COMPRESSIVE STRENGTH KN/MM^2
7 days	Concrete with partial replacement of 20% Silica fume and 25% GGBS	150x150	160	7.1	7.15
7 days		150x150	164	7.2	
28 days		150x150	280	12.4	12.6
28 days		150x150	286	12.7	

TABLE NO. 4 COMPRESSIVE STRENGTH FOR POROUS CONCRETE WITH PARTIAL REPLACEMENT OF 20% SILICA FUME AND 25% GGBS

CURING PERIOD	MIX RATIO	AREA OF SPECIMEN MM^2	MAXIMUM LOAD KN	COMPRESSIVE STRENGTH KN/MM^2	AVERAGE COMPRESSIVE STRENGTH KN/MM^2
7 days	Concrete with partial replacement of 20% Silica fume and 25% GGBS	150x150	160	7.1	7.15
7 days		150x150	164	7.2	
28 days		150x150	280	12.4	12.6
28 days		150x150	286	12.7	

CHART 1. 7 DAYS TEST RESULTS ON COMPRESSIVE STRENGTH

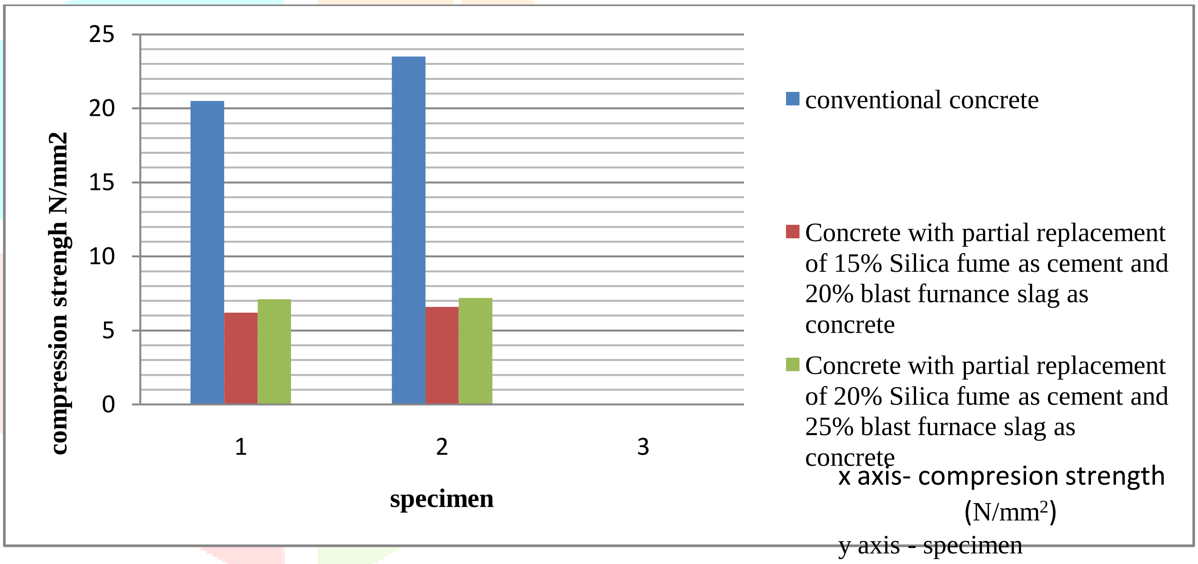
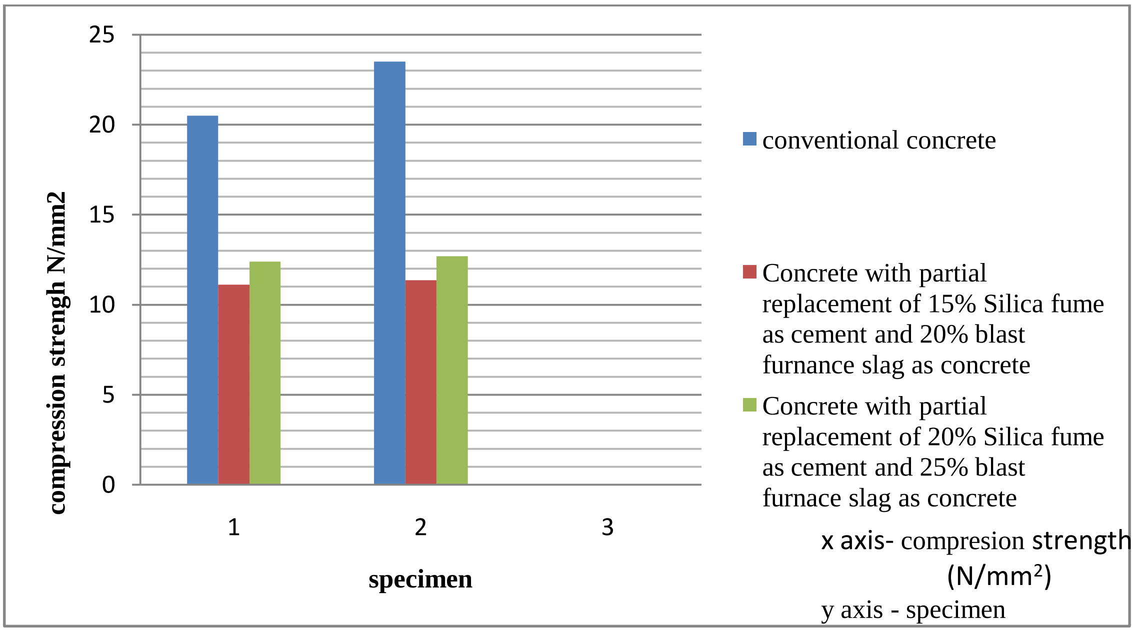


CHART 2. 28 DAYS TEST RESULTS ON COMPRESSIVE STRENGTH



VII CONCLUSION:

Porous concrete is a cost-effective and environmental friendly solution to support sustainable construction. Its ability to capture storm water and recharge ground water while reducing storm water runoff enables pervious concrete play a significant role. Due to its potential to reduce the runoff, it is commonly used as pavement Material. The mixtures with higher aggregate/cement ratio 3:1 and 4:1 are consideredto be useful for a pavement that requires low compressive strength and high permeability rate. The ideal pervious concrete mix is expected to provide the maximumcompressive strength, and the optimal infiltration rate.

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