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Experimental - Evaluation of Strength of Permeable Concrete for Ground Water Recharge in HBTU campus: Kanpur

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ABSTRACT

For the development of Smart Cities in India, we need to develop smart technologies and smart construction materials. Permeable concrete is one of the special type of concrete with high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge. In this type of concrete, no fine aggregate is used. Nowadays reduction in ground water recharge is leading to depletion of ground water table. Environmental protection agency implements sustainable storm water management which focuses on reducing storm water runoff thereby improving ground water quality. Due to the continuous urbanization along with the population growth, the land is being covered with impermeable surfaces such as residential, commercial buildings, highways, etc. Hence due to lack of permeability in the common concrete pavement, storm water is leading into the drains instead of getting filtered to the ground. This study focuses on the strength and permeability of permeable concrete. Experiments were carried out in Concrete laboratory of HBTU Kanpur. The size of coarse aggregate used in the test was 12.5 mm and 6.25 mm, the concrete mix ratio was 1:4.5. The Results are discussed in the following paper.

Keywords*: BUNA-S polymer, Permeable concrete, Permeability Coefficient, Mechanical Properties*

1- Introduction

Since concrete is an affordable and reliable material, it is extensively used throughout in the infrastructure of a nation‘s construction, industrial, transportation, defence, utility and residential sectors, thereby becoming a huge industry. In an undeveloped forest site, storm water runoff is less because of the process of infiltration into surfaces, evaporation from surfaces, and transpiration from vegetation. Very little storm water i.e., less than 1%, leaves the site in the form of runoff. Permeable concrete has become popular as an effective storm water management device in area that receives frequent and sometimes extensive rainfalls. However, as the urban areas is expanding, the vegetation cover is being replaced by infrastructures hence the water gets very less opportunity to infiltrate itself into the soil. Due to increasing urbanization in India and many parts of the world the problem of water logging and requirement of proper drainage has also increased. This is partly due to impervious nature of the bituminous and concrete pavements. Permeable concrete which has an open cell helps significantly to provide high permeability due to its interconnected pores. It can improve water quality by capturing the “first flush” of surface runoff, reduce temperature rise in receiving waters, increase base flow, and reduce flooding potential. The pavement creates a short-term storage detention of rainfall. In order to fully utilize these benefits, the hydrological behaviour of the pervious concrete system must be assessed. It is made using coarse aggregates with little to no fine aggregates. In addition to retention capabilities, a properly designed permeable provides durable riding surface. It also eliminates puddles and standing water, resulting in improved skid resistance. In addition to BUNA S polymer, natural sand was included to enhance the strength properties of pervious concrete. The test results indicate that it was possible to produce permeable

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concrete mixture with acceptable permeability and strength through the combination of BUNA S polymer and sand.

2- MATERIALS

2.1 Cement:

The Portland Pozzolana Cement, conforming to the IS requirement as per IS 1489 (PART 1). PPC was used for casting all the specimens. The type of cement used is important to ensure compatibility of chemical and mineral admixtures.

Table 2.1- Lab Test of Cement

Tests	**Value**
Normal consistency	32 %
Initial setting time	45 min
Final setting time	700 min
Soundness	3.40 mm
Specific gravity	3.14
Fineness	6.4%

2.1 Coarse aggregates and fine aggregates

Easily available crushed stones conforming to the IS: 2386 (Part III) – 1963 of aggregate size 12.5 mm and 6.25 mm as prescribed by the ACI -211, Appendix -6, and A6.2 were used. The size used was not more than 20mm. This aggregate type also has a great influence on concrete dimensional stability. Manufactured sand is used in 5%, 10%, 15%, and 20% by total aggregate weight.

2.3 Chemical admixture

The main aim of using chemical admixture was to increase the strength of permeable concrete as well as cementations properties. The chemical admixture used was BUNA-S polymer named after Fosroc chemical India private limited.

2.4 Water

Casting and curing is done with the help of tap water conforming to the IS 456(2000) recommended that the curing duration of concrete must be at least seven days in case of Portland Pozzolana Cement.

3- Methodology

3.1 Compressive Testing

The compressive testing of the samples was conducted after 7 days, 14 days and 28 days of curing. After performing the compressive testing of the test sample the following results were obtained.

Curing Period	1:4	1:4.5	1:5
7 days	1.45	1.12	0.81
28 days	2.18	1.67	1.40

Table 3.1-Compressive Strength of Sample

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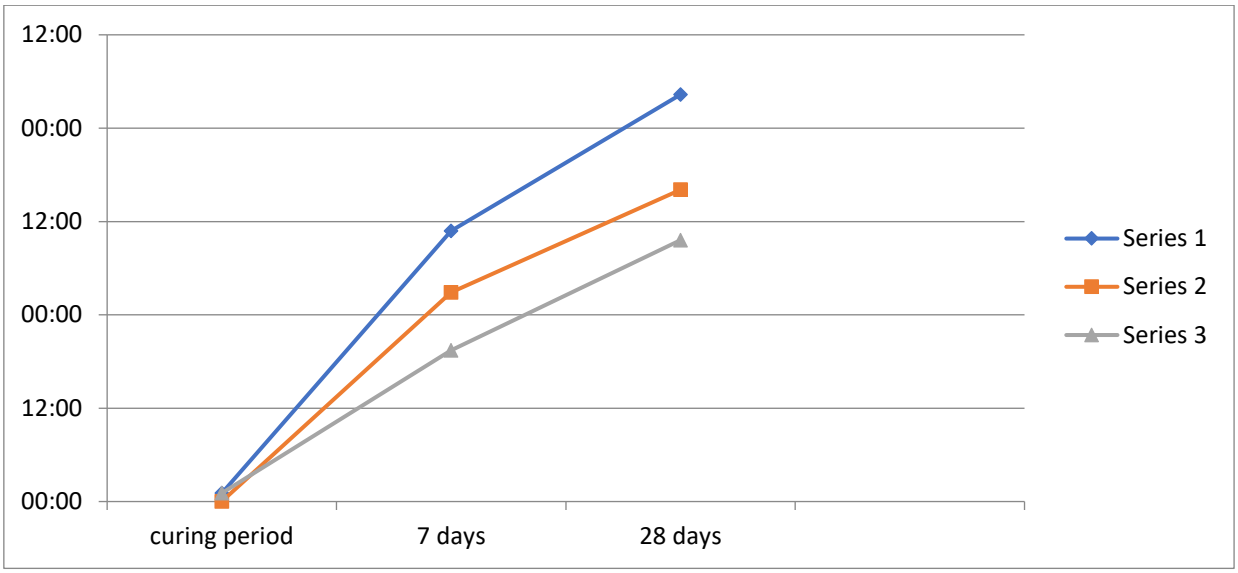

Fig 3.1 - Compressive test result of samples

3.2 Tensile Strength

The splitting cylinder test was performed to test the tensile strength of the concrete. The samples were tested after 7days and 28 days of curing.

Curing Period	1:4	1:4.5	1:5
3 days	10.69	6.54	6.53
7 days	11.58	9.32	9.68
14 days	14.65	13.14	12.13
28 days	17.73	14.58	11.83

Table 3.2- Tensile strength of sample

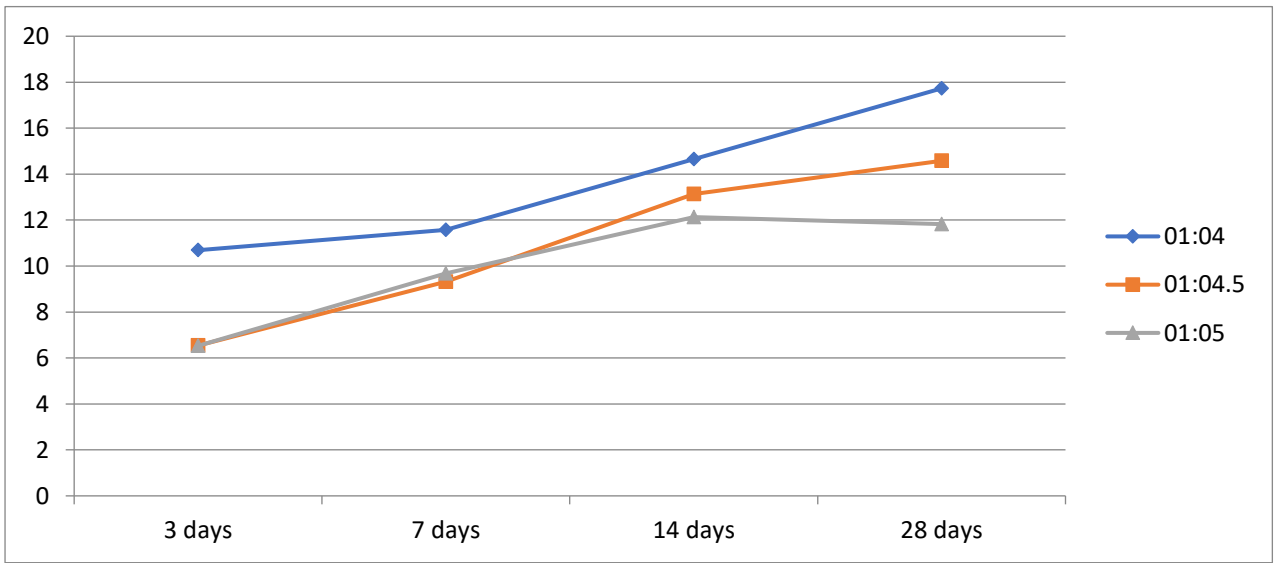

Fig 3.2 - Tensile test result for samples

4-Result

A comparative study is done by replacing the amount of Portland Pozzolana Cement with 10% by weight of BUNA-S polymer named after Fosroc chemical India private limited. The further work is continued by replacing the fine aggregate with coarse aggregate 10%, 20 %, and so on till 100%. The final value of compressive strength obtained by replacing 100% of fine aggregate with coarse aggregate is 23.3N/mm^2.

For enhancing the strength of these cubes and cylinders, the addition of BUNA-S polymer was done in the mix and 10% of the weight of cement in the mix was replaced by BUNA-S polymer. The water - cement ratio used in the mix ratio was 0.42. The 28-day strength was calculated as 23.3 N/mm^2 and permeability coefficient was 0.197 cm/sec. Mechanical properties of permeable concrete was found very well. Void content of this type of concrete is 20 - 35%.

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