Strength Development of Pervious Concrete with various Aggregate/Cement Ratio

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Abstract*: This paper evaluates the effect of aggregate/cement ratio on the strength development of pervious concrete. To evaluate this study, mixture proportions have been prepared by varying the aggregate/cement ratio and studying its compressive strength development. Four different aggregate cement ratios were chosen and its strength development at 7 days and 28 days is studied. It has been observed that lesser the aggregate/cement ratio greater the strength and vice versa

Keywords: ***Pervious concrete, compressive strength, void content***

I. INTRODUCTION

Pervious concrete is a new innovation in the field of concrete technology. It consists of a mixture of cement, coarse aggregate and water. The fine aggregate is completely eliminated to create the necessary voids in the pervious concrete mixtures. Fewer quantities of fine aggregate may be added to enhance the strength of pervious mixes. The final product consists of concrete with inter-connected voids which resulted in the permeation of water [1].

Pervious concrete has been used in United States as a storm water management solution. Pervious concrete has been designed based on the requirements or its application. Some mixes would require high permeability depending on the rain intensity in the area, while others would be strength driven [2]. There is no standard procedure for designing pervious concrete. Basic guidelines regarding mix proportions have been reported by NRMCA [3]. It has been stated that aggregate/cement ratio play a major part in the strength development of pervious concrete [4,5,6,7].

The compressive strength of pervious concrete depends mainly on porosity. The porosity of the concrete on the other hand depends on aggregate size, shape and gradation. Crouch et al. [8] found that a uniformly graded aggregate can results in higher compressive strength, and higher void ratio.

The objective of the present study is to evaluate the effect of aggregate cement ratio on the mechanical properties of pervious concrete. To achieve this, mix designs have been arrived with different aggregate cement ratios from 3.66:1 to 2.76:1 and studying its compressive strength.

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II. EXPERIMENTAL PROGRAM

A. *Materials and Properties*

Ordinary Portland cement (53 grade) Cement was used for the entire study. Locally available aggregates from Krishnankoil region were used and their characteristics are given in Table 1. Single size aggregate 12.5 mm was used for the entire study. Sieve analysis was performed as per IS 2386 and the results were tabulated in Table 2.

Table 1: Aggregate Characteristics

Details	
Specific Gravity	2.69
Water Absorption (%)	0.4
Loosely Packed Bulk Density	1403 kg/m^3
Dry Rodded Bulk Density	1632 kg/m^3
Aggregate Impact Value	17.02%

Table 2: Gradation of 12.5mm aggregate

Sieve Size (mm)	**Weight Retained**	**Cumulative Percentage**		**Specification as per IS 383 1970 Percentage passing for 12.5mm aggregate**
	g	**Retained**	**Passing**	**Single Size**
16	0	0.00	100	100
12.5	535	10.70	89.30	85 – 100
10	2218	55.06	44.94	0 – 45
4.75	1978	94.62	5.38	0 – 10

A. *Mix Proportions, Specimen preparation and Testing Methodology*

Based on the previous work on pervious concrete, we have chosen four different aggregate cement ratios and arrived at the other proportions using trial mixes. The cement and water cement ratio was fixed and only aggregate/cement ratio was varied. The final four mixes selected for detailed study is given in Table 3.

Table 3: Mix proportions of pervious concrete in SSD condition (kg/m^3)

Mix Id	Aggregate cement ratio	Cement kg/m^3	Coarse Aggregate kg/m^3	Density kg/m^3
P1	3.66:1	450	1649	2243
P2	3.36:1	450	1514	2108
P3	3.06:1	450	1380	1974
P4	2.76:1	450	1245	1839

III. Preparation of Test Specimens and Methodology

All the test specimens were cast using steel moulds. Concrete was filled in three layers and concrete was compacted using weights. Compaction was ensured that voids are not closed during compaction. After 24 hours, the specimen was demoulded and cured in curing tank till the age of testing. Fig. 1 shows the pervious concrete cubes after casting

The specimens were tested as per IS 516 for compressive strength at the end of 7 and 28 days.

Fig. 1. Pervious concrete after casting

IV. Results and Discussion

The compressive strength of pervious concrete at 7 days and 28 days are shown in Figure 2 and 3 respectively. From the compressive strength results it has been observed that concrete strength has been increasing with respect to the decrease in aggregate cement ratio at both 7 and 28 days. There was not much strength gain after 7 days like normal concrete. The strength gain of P1 to P3 after 7 days was around 21%, whereas in case of P4 it was around 47%. This could be due to the presence of more cement paste in P4 compared to other three mixtures. The density of P1 was around 2243 kg/m^3 and for P4 it was around 1839 kg/m^3. From the compressive strength it has been observed that strength increases with respect to the decrease in density. This could be mainly due to the aggregate cement ratio. Further investigations need to perform to strengthen the results.

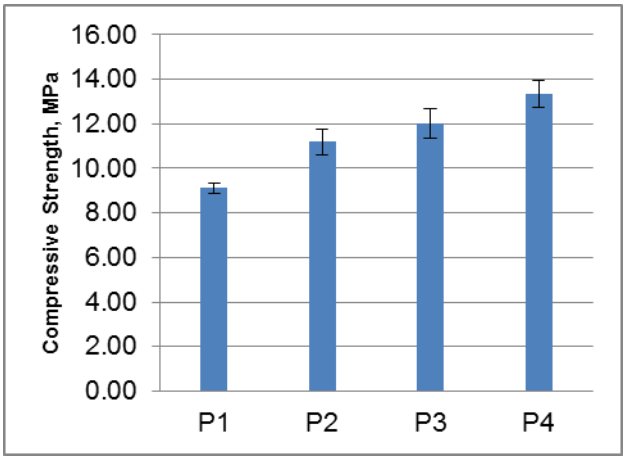

Fig 2. Strength of selected mixtures at 7 Days

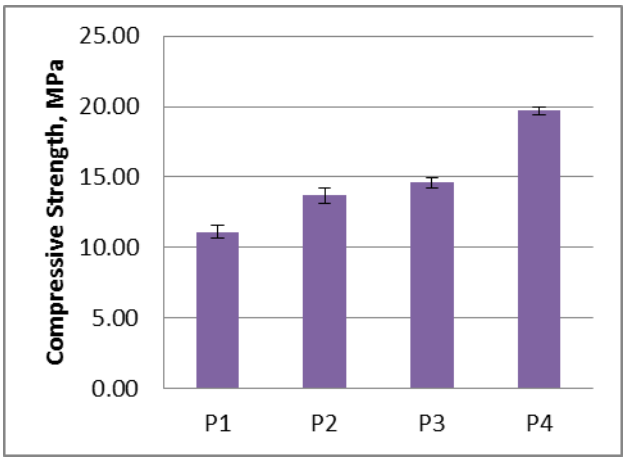

Fig.3 Strength of selected mixtures at 28 days

V. Conclusions

Based on the preliminary work on pervious concrete, we can conclude that,

1. Mixture P4 showed compressive strength of 19 MPa, which could be used for pavement applications
2. It was found that the increase in aggregate cement ratio resulted in lower strength
3. It was also observed that the compressive strength value increases with the reduction in density of concrete.

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Ramesh Babu Chokkalingam has completed his Ph.D. from IIT Chennai. He has more than 10 years of experience in teaching and research. His areas of research includes pervious concrete, geopolymer concrete, and high volume flyash concrete.

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