Improvement of Compressive strength of pervious Concrete

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ABSTRACT
This review paper includes literature reviews related to pervious concrete and effects of mineral admixtures (Fly ash and silica fume) on properties of concrete. Various research papers, articles and thesis have been referred to understand various aspects of the pervious concrete, viz., basic behavior, advantages, limitations, effects & mechanical properties. Various research papers published till date on different aspects of pervious concrete

KEYWORDS Pervious concrete, Porous material.

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I. INTRODUCTION

1.1 Pervious concrete
Conventional normal cement concrete is generally used as construction material of buildings. The impervious nature of concrete contributes to the increased water runoff into drainage system, over-burdening the infrastructure and causing excessive flooding in built-up areas. Pervious concrete has become significantly popular during recent decades, because of its potential contribution in solving environmental issues. Pervious concrete is a high-performance concrete which has relatively high-water permeability compare to conventional concrete due to interconnected pore structure. Pervious concrete is also termed as porous concrete and permeable concrete. It can be produced using conventional concrete-making materials, namely cement, cement supplementary materials, all types of coarse and no fine or less fine aggregates, and water. Pervious concrete is a type of concrete with significantly high-water permeability compared to normal weight concrete, it has been mainly developed for draining water from ground surface, so that stormwater runoff is reduced. Due to high water permeability then normal concrete, pervious concrete has very low compressive strength.

1.2 Mineral admixtures
Mineral admixtures are finally divided siliceous materials, which can be added to concrete in relatively large amounts, generally in the range of 15 to 60% by weight of cement. They may be pozzolanic or cementitious or both. Benefits of using mineral admixtures in concrete are improvements in high ultimate strength, resistance to thermal cracking and chemicals effects, better durability and economy. In this review paper, effects of fly ash and silica fume on concrete are referred.

II. METHODOLOGY

2.1 Compressive strength of pervious concrete
In the laboratory, pervious concrete mixtures have been found to develop compressive strengths in the range of 3.5 MPa to 28 MPa, which is suitable for a widerange of applications. Typical values are about 17 MPa. As with any concrete, the properties and combinations of specific materials, as well as placement techniques and environmental conditions, will dictate the actual in-place strength. However, currently there is no ASTM test standard for compressive strength of pervious concrete. Testing variability measured with various draft test methods has been found to be high

and therefore, compressive strength is not recommended as an acceptance criterion. Rather, it is recommended that a target void content (between 15% to 25%) as measured by ASTM C 1688: Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete be specified for quality assurance and acceptance.

2.2 Density and porosity:
The density of pervious concrete depends on the properties and proportions of the materials used, and on the compaction procedures used in placement. In-place densities on the order of 1600 kg/m³ to 2100 kg/m³ are common, which is in the upper range of lightweight concretes. A pavement 125 mm thick with 20% voids will be able to store 25 mm of a sustained rainstorm in its voids, which covers the vast majority of rainfall events in the U.S.

2.3 Permeability of pervious concrete

The permeability of pervious concrete was determined using a falling head permeability set up Figure 8. Water was allowed to flow through the sample, through a connected standpipe which provides the water head. Before starting the flow measurement, the samples were wrapped with polythene inside the cylinder. Then the test started by allowing water to flow through the sample until the water in the standpipe reached a given lower level. A constant time of 5 seconds was taken for the water to fall from one head to another in the standpipe. The standpipe was refilled and the test was repeated when water reached a lower. The permeability of the pervious concrete sample was evaluated from the expression given below:

Formula: \[ K = 2.303 \frac{aL}{A (t_2-t_1) \log (h_1/h_2)} \]

Where,
- \( a \) = the sample cross section area
- \( A \) = the cross section of the standpipe of diameter
- \( d \) = 0.95 cm²
- \( L \) = the height of the pervious concrete
- \( t_2 - t_1 \) = change in time for water to fall from one level to another (5 secs.)
- \( h_1 \) = upper water level
- \( h_2 \) = Lower water level
- \( D \) = diameter of sample (10.5 cm)
- \( d \) = diameter of standpipe (1.1 cm)

Theoretically, the coefficient of permeability generally in the order of 1 mm/sec for void ratio of 20% and the rate of flow is in the range of 120 liters/min/m² to 200 litres/min/m². In general, the concrete permeability limitation is not a critical design criterion. Consider a passive pervious concrete pavement system overlying a well-draining soil. Designers should ensure that permeability is sufficient to accommodate all rain falling on the surface of the pervious concrete. For example, with a permeability of 140 L/m²/min, a rainfall in excess of 0.24 cm/s would be required before permeability becomes a limiting factor. The permeability of pervious concretes is not a practical controlling factor in design. However, the flow rate through the sub grade may be more restrictive.

III. RESULT

The pervious concrete with 10% Rice husk ash as cement replacement gives highest value of compressive strength when compared to fly ash replacement and standard pervious concrete.

The pervious concrete with mixture of fly ash and rice husk ash gives least value of compressive strength. This may due to non-homogeneity between the two cementitious materials.

The co-efficient of permeability is maximum of 1.02 cm/sec for standard pervious concrete with 0% fine aggregates and minimum of 0.49 cm/sec for pervious concrete with 10% fine aggregates.

The pervious concrete with 10% fly ash has minimum co-efficient of permeability of 0.59 cm/sec and that of rice husk ash is 0.53 cm/sec. The reason for least values of permeability is due to fineness of cementitious materials.
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IV. CONCLUSION

- The size of coarse aggregates, water to cement ratio and aggregate to cement ratio plays a crucial role in strength of pervious concrete.
- The void ratio and unit weight are two important parameters of pervious concrete in the context of mix design.
- The compressive strength and co-efficient of permeability of pervious concrete are inversely proportional to each other up to addition of 8% of fines.
- The addition of fines and replacement of Cementitious will reduce the permeability capacity of pervious concrete.
- The compressive strength of pervious concrete is increased by 4.36% when 5% fine aggregates were added to the standard pervious concrete.

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