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editor@ijmece.com

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EXPERIMENTAL INVESTIGATION ON PERVIOUS CONCRETE

G.VIKAS[1], HARALE KISHAN RAO[2], K.VIKAS[3], KATAM AKSHAY REDDY[4], DR.K.SARGUNAN[5]

ABSTRACT

Pervious concrete is a special type of concrete with a 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. It is also called as porous concrete, permeable concrete, no fines concrete and porous pavement. Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. This type of concrete having a high void content of about 30%, is becoming popular nowadays due to its potential to reduce the runoff to the drainage systems which can provide a water flow rate around 0.34 cm/second. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to protect water quality . Pervious concrete also find its effective application in low loading intensity parking pavements, footpaths, walkways and highways. Pervious concrete has low installation costs. In addition, it filters the storm water thus reducing the number of pollutants entering the rivers and ponds. Pervious concrete also improves the growth of trees. In the present study the behaviour of pervious concrete has been studied experimentally. The water-cement ratio was kept at different ratios 0.35, 0.40, 0.45. Different properties of pervious concrete e.g. workability, compressive strength, split tensile strength, flexural strength test at 7, 14 & 28 days have been studied experimentally. The mix proportions with aggregates size (4.75 mm to 10 mm) gives higher strength when compared to mixes with aggregates size (10 mm to 20 mm) and (4.75 mm to 20 mm) respectively

INTRODUCTION

Construction technology has seen a rapid change over time. Many typical structures can be constructed within a month of duration using advanced construction techniques. Through it is proven that no construction can be done economically without using concrete.The word “concrete” originates from the Latin verb “concretes” which means to grow together.Concrete is a construction material that consists of cement, aggregate, and water. Concrete solidifies and hardens after mixture and placement due to a chemical process known as hydration. The water reacts with cement, which bonds the other components together and eventually creating a stone material. It is used to make pavement, architectural structure,

[1,2,3,4] UG Students, Dept of CIVIL, Malla Reddy Engineering College (Autonomous), Secunderabad, Telangana State.
[5]Professor, Dept of CIVIL, Malla Reddy Engineering College (Autonomous), Secunderabad, Telangana State.

foundation, overpasses, parking structure etc.., those concrete are rigid material with high compressive strength and weak in tensile strength. Reinforcing bars are used to improve the tensile strength. Fresh concrete is a freshly mixed material; which can be moulded into any shape, the relative quantities of cement, aggregate and water mixed together control the properties of concrete in the wet state as well as in the hardened state. The strength of concrete mainly depends on water cement ratio. If the water cement ratio increases then too much the bleeding of concrete takes place and the strength of concrete also reduced. Generally the high performance concrete usually contains ordinary Portland cement. The use of different types of sub-products into the cement based materials has become a common practice in concrete industry. Pervious concrete is an innovative material which is a mixture of coarse aggregate, cement, water and little to no sand containing a network of holes or voids, to allow air or water to move through . This allows water to drain naturally through it and allow replenishment of groundwater when conventional concrete does not. This innovative material sometimes called as No Fines Concrete also. Absence of sand or fine aggregate permit the properly placed pervious concrete to have about 15 to 30% of void space, the pores can range from 0.08 to 0.32 inches (2 to 8mm), which permit water to pass through without causing any damage to the matrix of the porous concrete .In the recent past due to climatic imbalance land is drying up causing a serious problem. Rather than building them with conventional concrete or asphalt, more and more communities, municipalities, and businesses are switching to pervious concrete or porous pavement, a material that offers the inherent durability and low life-cycle costs of a typical concrete pavement while retaining storm water runoff and replenishing local watershed systems.

LITERATURE SURVEY

Ravindrarajah Sri R. and Yukari A., (2010)They have studied the environmentally friendly pervious concrete for sustainable construction. This paper reports an experimental investigation into the, physical and engineering properties of pervious concrete having varying amount of low calcium fly ash as the cement replacement material. Various properties of pervious concrete were studied such as porosity, unit weight, and compressive strength, weight loss on drying, free drying shrinkage and water permeability under constant head. It seems that porosity has significant effect on compressive strength and permeability of pervious concrete. Replacement of 50% cement by fly ash had no significant effect on water permeability but it was noted that there is a marginal strength effect of pervious concrete. Three previous concrete mixtures were prepared by replacing 0,20 and 50% of fly ash and its properties were studied. Based on the data, it is obtained that there is a co-relation between strength and porosity and between permeability and porosity. It also found that pervious concrete maintain a porosity range of 15- 30%. Also it is assuming that replacement of 50% of cement has no significant effect on water permeability. So it is possible to prepare environment friendly pervious concrete with significantly reduced amount of Portland cement with fly ash.

ShackelB .,(2006) Yang J. and Jiang G.(2003) have evaluated the experimental study on properties of pavement material. In the present study porous material were introduced for roadway application. By introduction of smaller sized aggregate, super plasticizer and silica fume can enhance the strength of the pervious concrete. It is concluded that the material can achieve maximum compressive strength of 50 MPa and the flexural strength 6 MPa. Controlling the pressing force to keep the unit weight of 1900-2100 kg/m3 can ensure good wear penetration. Patil S.S and Khurd V.G (2016) have investigated the stress and deflection response analysis of a concrete pavement resting on elastic foundation (spring foundation) subjected to static circular wheel loads at interior, edge and corner part of concrete pavement by using Westergaard‟s closed form solution and compare the results with A3D-FE modelling in ANSYS. The study reveals that Finite Element Method can be applicable and reliable tool for concrete pavement analysis.

Ibrahim H.A and Razak H.A (2016) have studied the addition of palm oil clinker on properties of pervious concrete. In this study, Palm oil clinker is taken as the coarse aggregate in the fabrication of pervious concrete. Raw materials like Portland cement Type I,10 mm size coarse aggregate and fixed water-cement ratio of 0.3 are used. Here, natural aggregate are replaced by Palm oil clinker ranging from 0-100%. The test results indicated that substitution with POC decreases the strength of the material but porosity and permeability increases. The compressive strength of the material lies between 3.43- 9.52 MPa. It is noted that loss in strength was about 65% is observed full replacement. However, replacement of Palm oil clinker at 25% shows better performance among all. As such, it has been identified as the best mix for optimum performance of the POCPC.

Yeih W et al. (2015) have studied the engineering properties of pervious concrete made with air-cooling electric arc furnace slag as aggregates. It is observed from the experiment that porous concrete prepared from EAFS aggregates have better mechanical strength and water permeability than that made with natural river gravels. Apart from this porous concrete made with EAFS aggregates had a lower weight loss than that made with natural river gravels for the soundness tests. It is found that EAFS based pervious concrete has a higher water permeability and higher compressive strength than that made with gravels. The compressive strength is higher than 21 MPa and water permeability is 0.01 cm/s.

Gesoglu M. et al. (2014) investigating the properties of pervious concretes containing waste tire rubber. Three types of rubber were used in the production of rubberized plain pervious concrete mixtures which obtained by partially replacing the aggregate with rubber. Here, water-cement (w/c) ratio, moist curing period, and rubber contents by total aggregate volume were considered as experimental parameters. The results compared with non-rubberized pervious concrete (control) mixture. Finally it is concluded that the use of rubber significantly improve the engineering properties and permeability.

MATERIALS

The properties of materials used for making concrete mix are determined in laboratory as per relevant codes of practice. Different materials used in present study were cement, coarse aggregates, and fine aggregates, in addition to crushed PVC pipes. The

aim of studying of various properties of material is used to check the appearance with codal requirements and to enable an engineer to design a concrete mix for a particular strength.

Ordinary Portland cement Ordinary Portland cement is the most important type of cement and is a fine powder produced by grinding Portland cement clinker. The OPC is classified into three grades, namely 33 grade, 43 grade, 53 grade depending upon the strength of 28 days. It has been possible to upgrade the qualities of cement by using high quality limestone, modern equipment's, maintaining better particle size distribution, finer grinding and better packing. Generally use of high grade cement offers many advantage for making stronger concrete.Ordinary Portland cement (OPC) of 53 Grade (Ambuja cement) was used throughout the course of the investigation. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture. The various tests conducted on cement are initial and final setting time, specific gravity, fineness and compressive strength.

Aggregates Aggregates constitute the bulk of a concrete mixture and give dimensional stability to concrete. To increase the density of resulting mix, the aggregates are frequently used in two or more sizes. The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The fine aggregate is to assist the cement paste to hold the coarse aggregate particles in suspension. This action promotes plasticity in the mixture and prevents the possible segregation of paste and coarse aggregate, particularly when it is necessary to transport the concrete some distance from the mixing plant to placement. The aggregates provide about 75percentage of the body of the concrete and hence its influence is extremely important. They should therefore meet certain requirements if the concrete is to be workable, strong, durable and economical. The aggregate must be proper shape, clean, hard, strong, and well graded.

Coarse Aggregates: The aggregates which is retained over IS sieve 4.75mm is termed as coarse aggregate. The coarse aggregates may be of following types Crushed graves or stone obtained by crushing of gravel or hard stone .Uncrushed gravel or stone resulting from the natural disintegration of rocks .Partially crushed gravel obtained as product of blending of above two types .The normal maximum size is gradually 10-20 mm; however particle sizes up to 40mm or more have been used in self compacting concrete. Regarding the characteristics of different types of aggregate, crushed aggregates tend to improve the strength because of interlocking of angular particles, while rounded aggregates improved the flow because of lower internal friction .Locally available coarse aggregate having the maximum size of 20mm was used in this work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970. Specific gravity and other properties of coarse aggregates are given in table 3.1, 3.2. The sieve analysis of coarse aggregates was done.

RESULTS AND DISCUSSION

Test specimen of size 150mm x 150mm x 150mm was prepared and tested using the compressive testing machine. 28-day compressive strength tests were performed in accordance with ASTM C39, Standard Test Method for Compressive Strength of Concrete Specimens.

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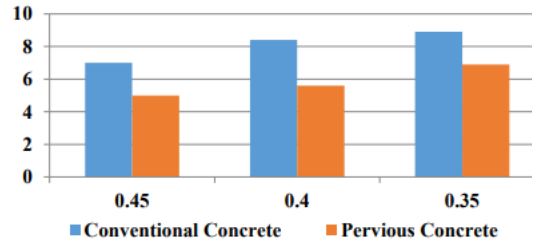
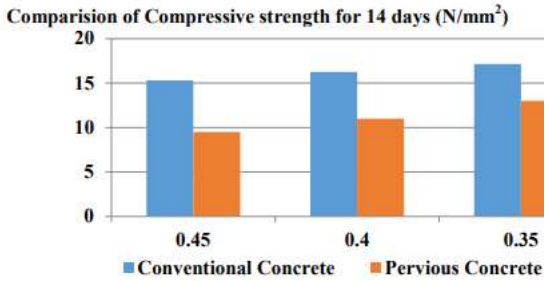
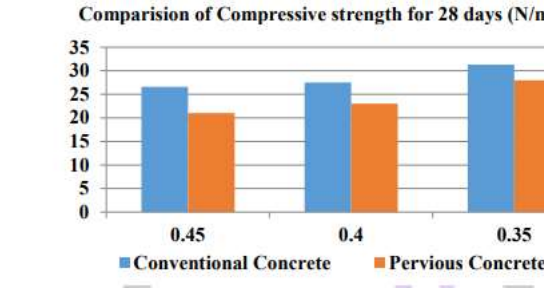


Fig.1. Comparision of Compressive strength for 7 days (N/mm2).





In the field, it appears that the rapid draining characteristics of pervious concrete prevent saturation from occurring. Anecdotal evidence also suggests that snow-covered pervious concrete clears quicker, possibly because its voids allow the snow to thaw more quickly than it would on conventional pavements. In fact, several pervious concrete placements in North Carolina and Tennessee have been in service for over 10 years. Note that the porosity of pervious concrete from the large voids is distinctly different from the microscopic air voids that provide protection to the paste in conventional concrete in a freeze-thaw environment. When the large open voids are saturated, complete freezing can cause severe damage in only a few cycles. Standardized testing by ASTM C 666 may not represent field conditions fairly, as the large open voids are kept saturated in the test, and because the rate of freezing and thawing is rapid. It has been shown that even after 80 cycles of slow freezing and thawing (one cycle/day), pervious concrete mixtures maintain more than 95% of their relative dynamic modulus, while the same mixtures showed less than 50% when tested at a more rapid rate (five to six cycles/day). It was noted that better performance also could be expected in the field because of the rapid draining characteristics of pervious concrete.Research indicates that entrained air in the paste dramatically improves freeze-thaw protection for pervious concrete. In addition to the use of air-entraining agents in the cement paste, placing the pervious concrete on a minimum of 6 inches (150 mm), and often up to 12 (300 mm) or even 18 inches (450 mm) of a drainable rock base, such as 1-inch (25-mm) crushed stone, is normally recommended in freeze-thaw environments where any substantial moisture will be encountered during freezing conditions.

CONCLUSION

This study illustrates angularity number, which influence properties and behavior of pervious concrete with coarse aggregates. The ideal pervious concrete mix is expected to provide the maximum compressive strength, and the optimal infiltration rate. Especially for pervious concrete used on roadways, there is the need for it to be able to withstand various traffic loadings while providing adequate infiltration to reduce surface run offs. From the results of the analysis, the Control Mix is recommended. The control design mix showed a maximum compressive strength of 31N/mm2 with a coefficient of permeability ranging between 57.8 and 299.5 in/hr. The standard Proctor Hammer compaction method appears to be the optimum procedure for preparing the

pervious concrete. Under real applications the water would have sent the cement completely through the aggregate and into the sub base, leaving the aggregate with little cement for bonding. Although a wide range of compressive strengths were obtained, none of the mixtures provide strength equal to that of conventional concrete.

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