Indian J.Sci.Res. 17(2): 237 - 240, 2018

ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

AN EXPERIMENTAL INVESTIGATION ON POROUS CONCRETE CONSTRUCTION

[1]Anne Mary J, [2]Jayanthi R, [3]Chinnasamy M
[1,3] Department of Civil Engineering, Veltech Dr.RR & Dr.SR University, Chennai.
[2] Department of Civil Engineering, Sriram Engineering College, Chennai, India.

***Abstract* -** To increase ground water level porous concrete can be used in pavement construction. For pavement construction of porous concrete cement, cementitious materials, admixtures water and aggregates are used. This concrete appears like honeycomb, voids present in it help rainwater to percolate. This experimental investigation explains about increased volume of coarse aggregate and reduction in the volume of fine aggregate in cement concrete mix. Coarse aggregate are in 10mm and 20mm grain size. In this experiment fine aggregate was replaced by 25%, 50%, 75 % and 100% with coarse aggregate, both 10mm and 20mm aggregate were used separately. As per IS code mix proportions has been designed. Concrete specimens was casted and tested for 14, 28, 60 days compression strength. According to IS standard specimens were casted for cubes, cylinder, beams. Experiment explains that the permeable level of conventional concrete is lower than porous concrete so porous concrete can be used for construction to recharge the ground water level.

***Key Words* -** Porous concrete, ground water level, Compression strength

I. Introduction

Porous 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 through it, thereby reducing the runoff from a site and recharging ground water levels. The high porosity is attained by a highly interconnected void content. Pervious concrete will have very little or no fine aggregate content. A cementations paste coated over the course aggregate particles is enough to hold aggregates and to have interconnectivity of the voids. Pervious concrete is generally used in parking areas, areas with light traffic, pedestrian walkways, and greenhouses.

Porous concrete produced from 20 mm and 10 mm coarse aggregates were tested in this work. They were also tested for the replacement of fine aggregate with coarse aggregate to obtain the benefits of porous concrete. Those benefits include cost effective, consumption of both raw material and chemical ingredients reduce the pollution in the environment, more effective at handling oil and grease, takes less time to install, has lower life-cycle cost, requires less maintenance and it helps ground water improvement. Pervious concrete can significantly reduce noise, by allowing air to be squeezed between vehicle tires and the roadway to escape. Porous concrete is otherwise called as pervious concrete or no fines concrete.

II. Literature Review

Aoki Y et al. (2012), have studied on properties of pervious concrete containing fly ash. Here the use of cement is partially replaced by fly ash in pervious concrete. Various properties of pervious concrete samples including density, porosity, compressive strength, water permeability and drying shrinkage have been carefully measured. The test result concluded that, higher porosity resulted higher water permeability but decrease in compressive strength. There was no significant difference between properties of pervious concrete samples containing fly ash and those samples comprising only cement as a cementitious agent.

Shackel B., (2006) have studied the Design of permeable paving subject to traffic. This paper describes the permeable paving offers significant benefits over conventional pavements in terms of sustainability and environmental impact. In particular the selection, specification and characterization of the materials used in the surface base and sub-base of permeable pavements require designers to modify existing design methodologies to facilitate water movement through the pavements whilst maintaining satisfactory serviceability under traffic in saturated conditions. The concepts of permeable pavement design are outlined and the need to integrate with water sensitive urban design principles is emphasized. Progress in the characterization and development of permeable pavement materials is described and current design data are assessed. The use of such data in the design of permeable pavements is then discussed.

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

[1]**Corresponding Author**

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.

III. Materials and Method

Portland pozzolana cement of specific gravity 3.19 is used in this work. River sand of specific gravity 2.68 and conforming Zone II as per IS: 383 is used as fine aggregate (FA). Coarse aggregates (CA) of specific gravity 2.72 are used. CA are of particle sizes 20 mm and 10 mm are used separately. Water which conforms to drinking water standards is used for the preparation of concrete.

An experimental investigation is designed for the estimation of compressive strength of concrete cubes and spilt tensile strengths when concrete is made by replacing of fine aggregate with coarse aggregates. Replacing fine aggregate with equal amount of coarse aggregate at the percentage of 25%, 50%.75%, 100% were carried out. It was decided to carry out the work with mix of grade M 20. The target mean strength is arrived as 27.49 N/mm^2. Mix design for M 20 was carried out for control concrete. Free water cement ratio required for the target mean strength 27.49 N/mm^2 is 0.48as per IS: 10262-1984. The mix proportion for control concrete is 1:1.441:3.033 when 20 mm aggregates are used. The mix proportion for control concrete is 1:1.40: 2.23 when 10 mm aggregates are used. Five mix ratios have been arrived and concrete was prepared for these mix ratios separately using 20 mm and 10 mm aggregates. The various quantity of materials used under proposed mix proportions for 20 mm size CA is given in Table 1 and for 10 mm size CA is given in Table 2. The various events of methodology is diagrammatically shown as flow chart in Figure 1. Various concrete specimens are prepared as per mix proportions arrived and cast into cube and cylindrical moulds and cured. The cube compression and cylindrical compressions tests were conducted on the specimens after 7, 14 and 28 days of curing. The mix ID 00FA stands for 0 % of FA in the mix, it may be named as no-fines concrete or pervious concrete or porous concrete.

Table 1 Proportions of materials for one cubic meter of concrete using 20 mm CA

Mix ID	Cement in kg	FA in kg	CA in kg	W in lit
CC 20	399.13	575.3	1211	191.6
75FA	399.13	431.48	1354.52	191.6
50 FA	399.13	287.65	1498.34	191.6
25 FA	399.13	143.83	1642.17	191.6
00 FA	399.13	0.00	1785.99	191.6

Table 2 Proportions of materials for one cubic meter of concrete using 10 mm CA

Mix ID	Cement in kg	FA in kg	CA in kg	W in lit
CC 10	446.3	625.8	994.03	214.2
75FA	446.33	469.35	1150.48	214.2
50 FA	446.33	312.9	1306.93	214.2
25 FA	446.33	156.45	1463.38	214.2
00 FA	446.33	0	1619.83	214.2

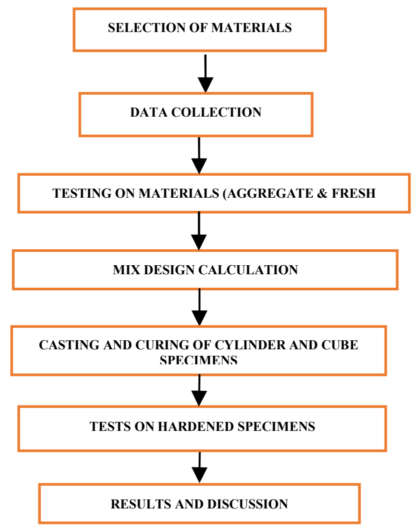

Figure 1 Flow chart of methodology

IV. Results and Discussion

Compression Strength

Higher compressive strength of concrete will increase its durability. Compressive strength also indicates extent of control exercised during construction. Both resistance to abrasion and volume stability improve with the compressive strength. Test for compressive strength is, therefore, very important in quality control of concrete. Preparation and conduct of compressive strength is comparatively easy. Test for determining compressive strength of concrete has, therefore attained maximum importance.

Cubes are removed from the curing tank, the moisture on surface or the cubes is wiped out with cotton. The dimension of the cubes are measured and noted. The specimen is placed in compression machine such that the traveled face is at top and the cube is placed at center of plates of the compression-testing machine. The load is applied axially of at an uniform intensity of 14N/mm^2 / minute till the specimen fails or crushed completely. The load at the failure point is noted. The average compression strength of three cubes is considered for the calculation of and tabulated. The compression strength of concrete prepared using 20 mm is given in Table 3. The average compression strength of all mixes produced using 20 mm aggregates are shown in Figure 2.

Table 3 Compression strength of cube specimens prepared using 20 mm aggregates

Mix ID	Average Comp Strength in N/ mm^2		
	7 days	14 days	28 days
CC 20	25.8	26.8	28.9
75FA	24.33	24.99	26.67
50 FA	23.78	24.33	25.78
25 FA	17.33	17.21	20.00
00 FA	14.00	14.10	16.44

Figure 2 Average compressive strength of all mixes produced using 20 mm aggregates

The compression strength values provide information about the development gradient of concrete strength and the development of early strengths. The compression study analysis has been made under three time intervals. A maximum compressive strength of 28.9 N/mm^2 was obtained in control mix CC20 and it is slightly higher than the target mean strength of 27.49 N/mm^2. The control mix attains 93.8 % of target mean strength in 7 days. The no fines mix 00FA attains compressive strength of 16.44 N/mm^2 after 28 days of curing, which is 59.8 % of target strength.

Table 4 Compression strength of cube specimens prepared using 10 mm aggregates

Mix ID	Average Comp Strength in N/ mm^2		
	7 days	14 days	28 days
CC 10	25.33	26.10	28.44
75FA	21.44	21.66	23.11
50 FA	18.55	19.66	21.33
25 FA	15.33	15.56	18.44
00 FA	11.21	11.55	14.55

Figure 2 Average compressive strength of all mixes produced using 10 mm aggregates

A maximum compressive strength of 28.44 N/mm^2 was obtained in control mix CC10 and it is slightly higher than the target mean strength of 27.49 N/mm^2. The control mix attains 89.06 % of target mean strength in 7 days. The no fines mix 00FA attains compressive strength of 14.55 N/mm^2 after 28 days of curing,which is 51.2 % of target strength.

V. Conclusions

The following are the major conclusion that is drawn from the present study:

- In this work compressive strength of porous concrete is less than the ordinary concrete.
- It is found that 59.8 % of strength attained in porous concrete after 28 days when 20 mm aggregates are used..
- It is found that 51.2 % of strength attained in porous concrete after 28 days when 10 mm aggregates are used.
- Surface of porous concrete was rough due to the absence of fine aggregate.
- Porous concrete construction is technically variable and feasible.

References

[1] Anne Mary J, et al (2017) “Improvement of Ground Water Level by Porous Concrete Construction” in IJCIET.

[2] Ajamu S.O., Jimoh A.A. and Oluremi J.R, Evaluation of Structural Performance of Pervious Concrete in Construction, International Journal of Engineering and Technology,2 (2012): pp.829-836.

[3] Alaica A.L. ,Dolatabadi M.H. Sucic A. and Shehata M.,Optimizing the strength and permeability of pervious concrete, Paper prepared for presentation at the permeable pavement design and technology session of the annual conference of the transportation association of Canada Halifax, Nova Scotia,(2010):pp.1-19.

[4] Aoki, Y. and Sriravindrarajah, R., Shrinkage of environ-mentally friendly sustainable porous concrete, Proceedings of the international conference on sustainable concrete construction. Ratnagiri, India, (2007):pp.1-4

[5] Amutha. R, Anitha. P, Keerthika. S“ Study On Properties Of Pervious Concrete Using Admixtures”

[6] ACI 552R (2010): “Report on Pervious Concrete”, American Concrete Institute, Farmington Hills, Michigan,

[7] Dan Miller and Aleksandar Mrkajic., “Portland Cement Pervious Concrete Pavement: Field Performance Investigation on Parking Lot and Roadway Pavements” Department of Civil & Environmental Engineering Fenn College of Engineering Cleveland State University.

[8] IS code 383-1970 “Specification for coarse and fine aggregate from natural sources for concrete”.

[9] Mulligan, Ann Marie, “Attainable Compressive Strength of Pervious Concrete Paving Systems,”Master of Science Thesis, University of Central Florida, Summer Term 2005.

[10] NRMCA, "Freeze Thaw Resistance of Pervious Concrete," National Ready Mixed Concrete Association, May 2004.

[11] Rangwala, S.C, "Engineering Material", Charotar Publicating house, Anand 1997.

[12] Shetty M.S – "Concrete Technology", S.chand & Company Ltd., 2003.

[13] Tennis, Paul D., Michael L. Leming, David J. Akers, "Pervious Concrete Pavements," PCA Engineering Bulletin EB 302, Portland Cement Association, 2004.

[14] S. K. Khanna, C. E. G. Justo NEM CHAND & BROS, Roorkee "Highway Engineering" (U.A) ISBN 81-85240-77-9 2.

[15] V. R. Patil , A. K. Gupta, D. B. Desai "Use Of Pervious Concrete In Construction Of Pavement For Improving Their Performance" ISSN: 2278-1684, PP: 54-56

www.iosrjournals.orgpg no: 55-56

[16] S. O. Ajamu, A. A. Jimoh, J. R. Oluremi "Evaluation of Structural Performance of Pervious Concrete in Construction" ISSN: 2049-3444 pg no: 829-835 4.

[17] California Department of Transportation "Pervious Pavement Design Guidance"

[18] U.S Department of Transportation, Federal Highway Administration "Tech Brief" December.

[19] Concrete Deliverswww.concreteparking.org

[20] Yang, J. and Jiang, G. Cement and Concrete

[21] Research Vol. 33,2003, pg no: 381- 38

[22] Tho-in T., SataV. Chindaprasirt P. and Jaturapitakkul C., Pervious high-calcium fly ash geopolymer concrete ,Construction and Building Materials,30 (2012):pp.366-371. 35)

[23] Tun Chi Fu. Weichung Yeih. Jiang Jhy Chang. and Ran Huang. , The Influence of Aggregate Size and Binder Material on the Properties of Pervious Concrete ,Advances in Materials Science and Engineering,2014 (2014): pp.1-17 36)

[24] Yang J., Jiang G., Experimental study on properties of pervious concrete pavement materials, Research,33 (2003): pp.381–386 37)

[25] Yeih W., Fu Tun Chi., Chang Jiang Jhy, and Huang Ran., Properties of pervious concrete made with air-cooling electric arc furnace slag as aggregates, Construction and building material, 93 (2015): pp.737–745