Evaluation & Optimization Of Pervious Concrete

Prof. S.S.Pawar[1], Mr. Ashutosh Gurchal[2], Digvijay Dange [3], Kunal Patil[4]
[1, 2, 3, 4] Dept of Civil Engineering
[1, 2, 3, 4] Padm. Dr. V. B. Kolte College of Engineering
Malkapur , Maharashtra, India

Abstract- *Pervious concrete is a special type of concrete, which consists of cement, coarse aggregates, water and if required, admixtures and other cementitious material. As there are no fine aggregates used in the concrete matrix, the void content is more which allows the water to flow through its body. So the pervious concrete is also called as Permeable concrete ad Porous concrete. There is lot of research work is going in the field of pervious concrete. The compressive strength of pervious concrete is less when compared to the conventional concrete due to is porosity and voids. Hence, the usage of pervious concrete is limited even though it has lot of advantages. If the compressive strength and flexural strength of pervious concrete is increased, then it can be used for more number of applications. For now, the usage of pervious concrete s mostly limited to light traffic roads only if the properties are improved, then it can also be used for medium and heavy traffic rigid pavements also. Along with that, the pervious concrete eliminates surface runoff of storm water, facilitates the ground water recharge and makes the effective usage of available land. The main aim of our seminar is to improve the strength characteristics of pervious concrete. But it can be noted that with increase in strength, the permeability of pervious concrete will be reduced. Hence, the improvement of strength should not affect the permeability property because it is the property which serves its purpose*

Keywords- Admisture 1, Aggrgate 2, Sand 3, Mix Design 4,

I. INTRODUCTION

After placement, pervious concrete has a textured surface which many find aesthetically pleasing and which has been compared to a Rice Krispy's treat. Its low mortar content and little (or no) fine aggregate content yield a mixture with a very low slump, with a stiffer consistency than most conventional concrete mixtures. In spite of the high voids content, properly placed pervious concrete pavements can achieve strengths in excess of 3000 psi (20.5 MPa) and flexural strengths of more than 500 psi (3.5 MPa). This strength is more than adequate for most low-volume pavement applications, including high axle loads for garbage truck and emergency vehicles such as fire trucks. More demanding applications require spec a mix designs, structural designs, and placement techniques. Pervious concrete is not difficult to place, but it is different from conventional concrete, and appropriate construction techniques are necessary to ensure its performance. It has a relatively stiff consistency, which dictates its handling and placement requirements. The use of a vibrating screed is important for optimum density and strength. After screening, the material usually is compacted with a steel pipe roller. There are no bull floats, derbies, trowels, etc. used in finishing pervious concrete, as those tools tend to seal the surface. Joints, if used, may be formed soon after consolidation, or installed using conventional sawing equipment. (However sawing can induce raveling at the joints.) Some pervious concrete pavements are placed without joints. Curing with plastic sheeting must start immediately after placement and should continue for at least seven days. Careful engineering is required to ensure structural adequacy, hydrologic performance, and mm mum clogging potential. More detail on these topics is provided in subsequent sections..

II. MIX DESIGN

Material

Material Materials Pervious concrete uses the same materials as conventional concrete, with the exceptions that the fine aggregate typically is eliminated entirely, and the size distribution (grading) of the coarse aggregate is kept narrow, allowing for relatively little particle packing. This provides the useful hardened properties, but also results in a mix that re quires different considerations in mixing, placing, compaction, and curing. The mixture proportions are somewhat less for giving than conventional concrete mixtures—tight controls on batching of all of the ingredients are necessary to provide the desired results. Often, local concrete producers will be able to best determine the mix proportions for locally available materials based on trial batching and experience. Table 3 provides typical ranges of materials proportions in pervious concrete, and ACI 211.3 provides a procedure for producing pervious concrete mixture proportions.

Cementitious Materials As in traditional concreting, port-land cements (ASTM C150, C157) and blended cements (ASTM C595, Cl57) may be used in pervious concrete as per IS Code 1489:1991. In addition, supplementary cementitious materials (SCM5), such as fly ash and pozzolanas (ASTM C618) and ground-granulated blast furnace slag (ASTM

C989), may be used. Testing materials beforehand through trial batching is strongly recommended so that properties that can be important to performance (setting time, rate of strength development, porosity, and permeability, among others) can be determined. The water cementitious material ratio (w/cm) is an important consideration for obtaining desired strength and void structure in pervious concrete. A high w/cm reduces the adhesion of the paste to the aggregate and causes the paste to flow and fill the voids even when lightly compacted. A low w/cm will prevent good mixing and Page 26 tend to cause baling in the mixer, prevent an even distribution of cement paste, and therefore reduce the ultimate strength and durability of the concrete. W/cm in the range of 0.26 to 0.40 provides the best aggregate coating and paste stability. The conventional w/cm-versus compressive strength relationship for normal concrete does not apply to pervious concrete. Careful control of aggregate moisture and w/cm is important to produce consistent pervious concrete

Aggregate Fine aggregate content is limited in pervious concrete and coarse aggregate is kept to a narrow gradation. Commonly used gradations of coarse aggregate as per IS code 10262:2009 include ASTM C33 No.67 (¾ in. to No. 4), No. 8 (¾ in. to No. 16), or No. 89 (¾ in. to No. 50) sieves [in metric units: No. 67 (19.0 to 4.75 mm), No. 8 (9.5 to 2.36 mm), or No. 89 (9.5 to1.18 mm), respectively]. Single-sized aggregate up to 1 in. (25 mm) also has been used. ASTM D448 also may be used for defining grading. A narrow grading is the important characteristic. Larger aggregates provide a rougher surface. Recent uses for pervious concrete have focused on parking lots, low- traffic pavements, and pedestrian walkways. For these applications, the smallest sized aggregate feasible is used for aesthetic reasons. Coarse aggregate size 89 (¾-in. or 9.5-mm top size) has been used extensively for parking to and pedestrian applications, dating back 20 years or more in Florida. Generally, NC ratios are in the range of 4.0 to 4.5 by mass. These NC ratios lead to aggregate contents of between about 1300 kg/rn3 to 1800kg/rn3. Higher NC ratios have been used in laboratory studies but significant reduce tons strength result.

Water to cementitious materials ratio is 0.27 to 0.30 and is used routinely with proper inclusion of chemical admixtures, and those as high as 0.34 and 0.40 have been used successfully. The relation between strength and water to cementitious materials ratio is not clear for pervious concrete because unlike conventional concrete, the paste content is less than the voids content between the aggregate. Therefore, making the paste stronger may not always lead to increased overall strength. Water Page 27 content should be tightly controlled. The correct water content has been described as giving the mixture sheen, without flowing off of the aggregate. A handful of pervious concrete formed into a ball will not crumble or lose its void structure as the paste flows into the spaces between the aggregates . Water quality is discussed in ACI 301. As a general rule, water that is drinkable is suitable for use in concrete. Re cycled water from concrete production operations may be used as well, if it meets provisions of ASTM C94 or AASHTO M 157. If there is a question as to the suitability of a water source, trial batching with job materials is recommended.

Admixtures Chemical admixtures are used in pervious concrete to obtain special properties, as in conventional concrete. Because of the rapid setting time associated with pervious concrete, retarders or hydration-stabilizing admixtures are used commonly. Use of chemical admixtures should closely follow manufacturer's recommendations. A reentering admixture can reduce freeze-thaw damage in pervious concrete and are used where freeze-thaw is a concern. ASTM C494 governs chemical admixtures, and ASTM C260 governs air reentering admixtures. Proprietary admixture products that facilitate placement and protection of pervious pavements are also used.

In this paper the effect of fine aggregate in strength and durability properties of pervious concrete is mentioned. 42 specimens were cast cured and tested for compressive strength, flexural strength, and void ratio. Applications of Pervious Concrete are mentioned as well as, Benefits of Pervious Concrete Pavement; Environmental Benefits Economic Benefits Structural benefits are given in this study. Materials are cement, fine aggregates, coarse aggregates and water. The properties of these materials are given in detail. Cement properties such as Sp. Gravity of Cement Consistency, Initial Setting Time, Final Setting Time, Fineness Test and Soundness are found out. Aggregates properties such as Sp. Gravity, Water Absorption, Crushing Value, and Flakiness Index are explained. Water properties such as Chloride, Sulphate, Organic Solids, Inorganic Solids, Suspended Matter, pH Value are calculated. As per the ACI mix design procedure followed and explained in detail.

Mix	Cement in Kg	Fine Aggregate in kg		Fine Aggregate in kg	
		River sand	Crushed Stone sand	20mm	12mm
M1	330	-	-	1447	-
M2	330	-	-	-	1447
M3	330	145	-	1447	-
M4	330	145	-	-	1447
M5	330	-	-	724	724
M6	330	-	145	1447	-
M7	330	-	145	-	1447

Compressive Strength, Flexural Strength, Void Ratio of all mixes M1, M2, M3, M4, M5, M6, M7 are compared with each other. By comparing it is found that increase in void ratio give reduction in Compressive Strength and Flexural Strength. The strength of pervious concrete with 12mm aggregates is more than 20 mm aggregates. Mix M4 has the high value of Compressive Strength, Flexural Strength, and Void Ratio as compared to other. Mix M4 can be used as M10 grade of pervious concrete from both strength and void ratio properties

In sample no.1, admixture used was Sika Vis cocrete 5001. TYPE A – Cement (PPC): 10 kg Fly Ash (P-63): 0 kg Coarse aggregate: 52 kg (10 – 40 mm) Water: 3 kg Admixture: 1% by weight of [cement + fly ash] = 100 gm. TYPE B – Cement (PPC): 11.25 kg Fly Ash (P-63): 0.75 kg Coarse aggregate: 52 kg (10 – 40 mm) Water: 3.33 kg Admixture: 1% by weight of [cement + fly ash] = 120 gm. The tests results are taken after 3 days, 7 days, 14 days. According to the results it was found that as the density of cube increases the strength get increased. The cubes are not perfectly pervious. So in next sample different type of proportion of admixture is taken. 3 cubes were casted with different proportion of admixture. Page 30 In sample 2, mix design used was of TYPE B assist strength is higher than that of TYPE A Sample no. 2: Mix design for 1 cube as per TYPE B: Cement: 1323 gm. Fly Ash: 88.23 gm. Coarse aggregate: 6117 gm. TYPE B1: Admixture: 0.2% = 2.82 gm. Water: 510 gm. TYPE B2: Admixture: 0.3% = 4.23 gm. Water: 480 gm. TYPE B3: Admixture: 0.4% = 5.64 gm. Water: 460 gm. The tests results are taken after 3 days. Use of low % of admixture gives result not perfectly pervious. It is due to large size of some aggregates. In sample 3, aggregates used in the size range of 10 –20 mm, admixture percentages are also increased. Sample no. 3: Sample of 3 cubes: Cement: 3.75 kg, Fly Ash: 255 gm., Coarse aggregate: 17.31 kg, Admixture: 7 gm., Water: 1.36 kg 7 days cube testing is done. After so many trials and change in water & admixture quantity, perfectly pervious concrete can't be achieved. Due to settlement of cement-water slurry. In sample 4, compaction and vibrators are not used while filling the cube. Sample no. 4: Mix design for 1 cube: (w/o compaction) Cement: 1 kg, Fly Ash: 0 kg, Coarse aggregate: 5.2 kg, Admixture: 2.33 gm., Water: 380 gm. 3 days cube testing is done. This time the cube made was perfectly pervious. The cube has shining appearance. In sample 5: mix design for 2 cubes (w/o compaction) Cement (PPC): 2 kg, Fly Ash: 0 kg, Coarse aggregate: 10.4 kg, Admixture: 4.66 gm., Water: 760 gm. Finally, in all samples number 4 and 5 are the successful with maximum strength and perfectly pervious with good appearance. This to be done with low w/cm ratio and w/o compaction. Page 31 In sample 1 , 2 & 3 the aggregates used are above 20mm and compaction is done due to this cubes are not porous, cement slurry settled down and this made bottom surface flat. So use of aggregates size 10mm to 19mm is good for perfect pervious concrete and high strength.

III. FUTURE SCOPE

Compared to conventional concrete, pervious concrete has a lower compressive strength, greater permeability, and a lower unit weight (approximately 70% of conventional concrete). However, pervious concrete has a greater advantage in many regards. Nevertheless, it has its own limitations which must be put into effective consideration when planning its use. In both developed and developing countries waste management problem has already become severe. The problem is compounded by the rapidly increasing amounts of industrial wastes of a complex nature and composition. Energy plays a crucial role in the growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building Materials like cement, the importance of using industrial waste cannot be underestimated. Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability. Recent researchers aimed at the conservation in the cement and the concrete industry focused on the use of waste materials waste glass such as glass powder, hypo sludge, ceramic waste, rice husk ash such as fly ash, slag, silica fume in pervious concrete to increase the strength and permeability of pervious concrete. Many researchers have made attempts to use the waste materials to reduce the disposal problems and to improve the mechanical properties of pervious concrete.

IV. CONCLUSIONS

The following conclusion comes through the study of pervious concrete pavement in rural areas becomes more suitable to meet the rural area requirement such as:

- Cities with pervious pavements would be safer for traffic, be cleaner and less pollution.
- It cannot be used for heavy or medium traffic pavements due to less compressive strength of the pervious concrete block.
- To reduce the storm water runoff.
- To increase the ground water level.
- To eliminate costly storm water management practices.
- It is crystal clear that the utilization of these waste materials is beneficial from the environmental as well as economical point of view.
- It is exceptionally good method to improve sustainability of construction.

- As no fines concrete contains no sand and consequently requires considerably less cement per cubic yard of concrete, there is direct saving in material.
- Fly ash results in higher infiltration rate due to more voids as compared to alccofine which results in lower infiltration rate.
- Overall, it is expected that the present research will help to understand the pore network characteristics of pervious concrete using non-destructive evaluation and digital image processing.
- From review it is studied that the strength of pervious concrete get decreases as compared to conventional concrete. And also can be concluded that the 12 mm size aggregate is appropriate for preparing pervious concrete.
- For mix design of pervious concrete, the IS code method can be used but a definite method is not available and it is found that the pervious concrete gives better results imparting super plasticizer. For the best result it can be suggested that to keep cement to aggregate ratio as 1:3

Pervious concrete, although not as strong as conventional concrete, provides an acceptable alternative when used in low volume and low impact areas. Strength is sacrificed for permeability but not to any degree which would render the pervious concrete non-functional.

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