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A REVIEW ON MIX DESIGN FOR PERVIOUS CONCRETE

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ABSTRACT

Now days water logging of parking and walkway is the major problemfaced especially during monsoon, as pavement and floors are normally impermeableso there are very less chances for percolation of water. This problem can be overcome by introducing pervious concrete instead of impervious layers.Pervious concrete is a high porosity concrete used for outdoor flatwork that allows water to pass through it. It has a low water/cement ratio, low-slump mix consisting of cement, narrowly graded coarse aggregate, little or no fine aggregate, water and admixtures. The popularity of pervious concrete continues to rise with the increased awareness of environmental protection and preservation.

The main aim of this review study is to study the effect of different sizes of aggregate and the different mixes on the properties of pervious concrete. As the pervious concrete can be the solution for increasing infiltration of water into the ground and decreasing the runoff due to its porous nature.

Keywords: Flexural strength, Mix design,pervious concrete,

I.INTRODUCTION

Now as population growth is increasing rapidly, and more and more area is undergoing into impervious spaces like bituminous road, parking lots, etc therefore it isnecessary todecrease impervious surface areas, which block the percolation of precipitation from rainfall and snow down through the ground. On the other side, pervious concrete has the ability to reduce runoff volume and improve water quality by increasing infiltration. Such permeable concrete can contribute to solving drainage problems and reducing the risk of flooding, resulting from continuous urban developments. For A successful mix design for pervious concrete should consist of an ideal composition of materials to give the best result in terms of permeability, strength, and durability. The most important condition in the design of pervious concrete is to keep the continuity of cement paste with coarse aggregate embedded so that continuous voids are maintained. This paper gives the idea about the mix design and the result.

II.LITERATURE ON PERVIOUS CONCRETE

M. HarshavarthanaBalaji, M.R.Amarnaath, R.A.Kavin, S. Jaya Pradeep(2015)[1], "DESIGN OF ECO FRIENDLY PERVIOUS CONCRETE"

Thispaper gives description of flexible vs pervious pavement, flexible have low flexural strength and pervious have high flexural strength.Water purifying performance is described, Water purification by pervious concrete is a sort of inter-gravel contact oxidation, in whichcontinuous voids provides an additional bio-purification function, also the pervious concrete as noise absorption is described.

Cement used is Ordinary Portland cement, 53Grade conforming to IS: 269 – 1976.Ordinary Portland cement, 53 Gradewas used for casting all the Specimens. Coarse Aggregate Locally available crushed blue granite stones conforming to graded aggregate of nominal size 12.5 mm as per IS: 383 – 1970, Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens.

Based on ACI 522R-06 they have laid the mix design as Cement: Aggregate: Water = 1: 2.91: 0.31And the quantities of materials required per m^3 concrete are: Cement: 540 Kg/m^3C.A: 1746 Kg/m^3Water: 186 Kg/m^3Silica fume: 60 Kg/m3. From this mix design the cubes (150x150x150mm) are casted and the results of 3 days, 7 days,14 days, 21 days ,27 days strengths are taken which shows result as 7.32, 17.16, 23.4, 24.57, 25.73 KN.

From the test experiments it was found that the mix design with aggregate and cement ratio of 3 has the maximum strength. From this mix design required strength can be obtained for M20grade concrete.So we can choose this mix design for the application purpose.

Dhawal Desai, "Pervious Concrete – Effect of Material Proportions on Porosity"[(2)],

This paper studies the effect of size of aggregates and proportions of cement, aggregates, admixture and water on porosity of Pervious concrete which is the main function of pervious concrete. Typically pervious concrete has water to cement ratio (w/cm) of 0.28 to 0.40 and for such ratio void content are18 to 35%. The general properties of pervious concrete are Void content: 18-35% Strength: 28-281 kg/cm Infiltration rate: 80-720 liter per min per sqm Cement: 267-415 kg/m w/cm ratio: 0.26 – 0.40 Coarse aggregate: 9.5 – 19mm.

Different sample blocks are casted by using different proportions of cement, aggregates, admixture and water.

For first sample they have prepared two types of mix design (TYPE -A and TYPE-B) with different ratios and then tests results was carried out as.

In sample no.1

Admixture used was 'Sika Viscocrete 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.

For sample 2 mix design used was of TYPE B asits 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 give result not perfectly pervious. It is due to large size of some aggregates.

For the next 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.

For next 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.

Sample no 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.

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.

S. Rajesh Kumar 'Characteristic Study on Pervious Concrete' (2015)[3]

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.Application of Pervious Concrete are mentioned as well as Application of pervious Concrete, Benefits of Pervious Concrete Pavement, Environmental Benefits Economic Benefits Structural benefits are given in this study.

Materials are cement, fineaggregates, 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 find out. Aggregates properties such as Sp. Gravity, Water Absorption, Crushing Value, 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.

As per mix design 42 specimens are casted, out of 42 specimens 21 are 150 X 150 mm cubes and remaining 21 are 100 X 100 X 500 mm beams. 7 types of mixes with and without fine aggregates and with 12 mm, 20 mm coarse aggregates separately and together are used.

Table1Mix Proportions for Different Mixes[3]

Mix	Cement in Kg	Fine Aggregates in Kg		Fine Aggregates 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, Void Ratio as compared to other.

Mix M4 can be used as M10 grade of pervious concrete from both strength and void ratio properties.

K.Rajasekhar, K.Spandan,"Strength Properties of Pervious Concrete Compared with Conventional Concrete"(2016)[4]

This paper gives the results of investigation in the development of pervious concrete with reduced cement content and coarse aggregate for sustainable permeable pavement construction. The super plasticizer conplast SP430 to reduce the amount of water content is used. The compressive strength ofpervious concrete is taken after curing of 3, 7 and 28days. The properties of super plasticizer conplast SP430 are explained in detail.

The void ratio and specific gravity of conventional concrete and pervious concrete are find out. The properties of cement, fine aggregates and coarse aggregates are explained in detail. The sieve analysis of fine aggregate and coarse aggregates is done. Fine and coarse aggregates are used for conventional concrete and only coarse aggregates are used for previous concrete.

The mix design for conventional concrete is C: FA: CA= 1: 1.3: 2.436

The mix design for pervious concrete is C: FA:CA= 1: 0: 4

The quantities of materials for $1M^3$ are calculated in detail.

Table 2 Quantities of Material Require per $1m^3$ (4)

Concrete type	W/C Ratio	Cement (kg)	F.A (kg)	C.A (kg)	Water (lit)	Super plasticizer (ml/cement)
Conventional concrete	0.35	531	672	1133	186	-
Pervious concrete	0.35	531	-	2124	186	5310

Workability for conventional and pervious concrete is calculated,

For conventional concrete, slump value = 70mm, compaction factor =0.85,

For pervious concrete, slump value = 80mm, compaction factor =0.82,

Dose of super plasticizer in ml/100Kg of cement = 1000

The compressive strength of pervious concrete and conventional concrete for 3days, 7days and 28days are taken. These values of pervious concrete are 7MPa, 15MPa and 22MPa respectively and for conventional concrete were 28.22MPa, 39.78MPa and 46.5MPa respectively.

The split tensile strength of pervious concrete and conventional concrete for 3days, 7days and 28days are taken. These values of pervious concrete were 1.2MPa, 1.5MPa and 1.8MPa respectively and for conventional concrete were 2.5MPa, 3MPa and 3.25MPa respectively.

The flexural strength of pervious concrete and conventional concrete for 3days, 7days and 28days are taken. These values for pervious concrete were 2MPa, 2.1MPa and 2.5MPa respectively and for conventional concrete were 4MPa, 5.97MPa and 6.14MPa respectively.

The the percentage decrease in compressive strength , split tensile strength , flexural strength are calculated.

The percentage decrease in compressive strength of pervious concrete is 50 to 75% compared with conventional concrete. The percentage decrease in split tensile strength of pervious concrete is 45 to 50% compared with conventional concrete. By comparing between pervious and conventional concrete both are very different.

III.CONCLUSION

The main aim of this review study is to study the effect of different sizes of aggregate and the different mixes on the properties of pervious concrete. As the pervious concrete can be the solution for increasing infiltration of water into the ground and decreasing the runoff due to its porous nature.

From review it is studied that the strength of pervious concrete get decreases as compared to conventional concrete. And alsocan 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

IV.ACKNOWLEDGEMENT

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