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Performances of Thirsty Concrete

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Abstract: Pervious Concrete is a special type of concrete, which consist of cement, coarse aggregates, water and if required admixtures and other cementitious materials. As there are no fine aggregates used in the concrete mix, the void content is more which allows the water to flow through its body. So, the Pervious Concrete is also called as Permeable Concrete and 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 its porosityand 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 fora greater number of applications. For now, the usageof Pervious Concrete is 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 Pervious Concrete can be an important part of context-sensitive construction and low-impact development used to improve water quality by capturing the “first flush” of surface runoff, reducing temperature riseinreceiving waters, increasing base flow, and reducing flooding potential by creating short term storage detention of rainfall. In order to fully utilize these benefits, the hydrological behavior of the pervious concrete system must be assessed. The hydrological performance is usually a key parameter in decisions to use this material as a best management practice for storm water management.

Pervious Concrete is an important application for the sustainable construction and is one of many low impact development techniques used by builders to protect water quality.

Index Terms - Concrete, cement, Pervious Concrete structure, storm water

1. INTRODUCTION

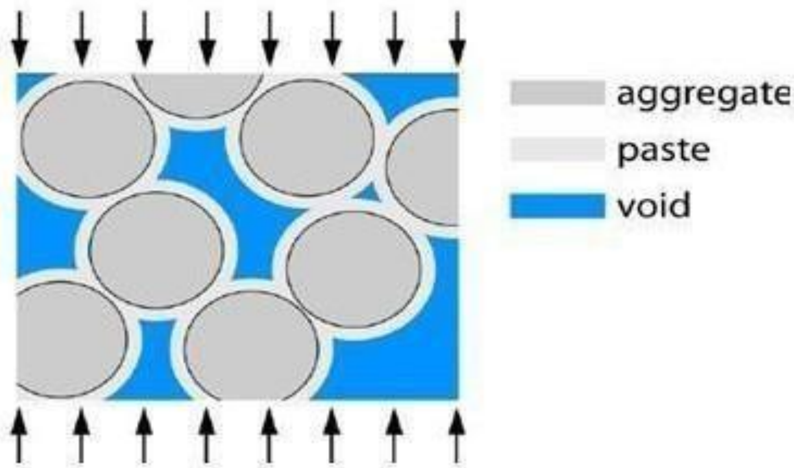
1.1 GENERALABOUTPERVIOUSCONCRETE

Pervious Concrete, which is also known as the no-fines, porous, gap-graded, and permeable concrete and enhance porosity concrete has been found to be a reliable to water management tool. Pervious Concrete is a mixture of gravel or granite stone, cement, water, with or without admixtures. When Previous Concrete is used for paving, the open cell structures allow storm water to filter through the pavement and into the underlying soils. In other words, Previous Concrete helps in protecting the surface of the pavement and its environment. As stated above, Previous Concrete has the same basic constituents as conventional concrete that is; 15%-30% of its volume consists of interconnected void network, which allows water to pass through the concrete. Pervious Concrete can allow the passage of [11.33-18.97] liters of water per minute through its open cells for each square foot (0.0929m^2) of surface area which is far greater than most rain occurrences.

Pervious Concrete is a special concrete used to intentionally allow water to pass through the surface of a pavement and allow storm water to eventually absorb back into the surrounding soils or evaporate. This keeps runoff water from downstream urban flooding and erosion. It also breaks the cycle of water treatment plants needing to treat storm water where municipalities have combined sewer and storm water systems. Pervious Concrete pavements are “Best Management Practices” (BMP’s) to collect, clean and cool storm water. This usually eliminates the need for detention/retention ponds, thus reducing construction expenses, safety issues, and maintenance.

The voids maintained throughout the structure due to the single-diameter aggregates being held together with the thin cement paste allow air or water to penetrate through the Pervious Concrete.

1.1.A PerviousConcreteblock



1.1.B Schematicdiagramof PerviousConcretestructure

Because the cement paste that binds the structure together is thin, this reduces the strength of pavement. For this reason, Pervious Concrete would not be appropriate for highway use, as it would need to accommodate for high volume of heavy vehicle traffic each day. It could however be implemented on the highway shoulders, which do not carry the repetitive loads of vehicle traffic each day. Also, because Pervious Concrete has numerous voids exposed to the surface, it is prone to clog with debris, which could hinder water from infiltrating through the structure. Thiscanbepreventedwithpropermaintenancetechniques.Thesepropertiesare important for the proper functionality of this material. Higher compressive strength is a plus but not a determining factor for quality.

Previous Concrete is also a unique and effective means to address important environmental issues and sustainable growth. When it rains, Previous Concrete automatically acts as a drainage system, thereby water percolates back in ground where it belongs. Previous Concrete is rough textured, and has a honeycombed surface, with moderate amount of surface raveling which occurs onheavily travelled roadways. While casting carefully controlled amount of water and cementations materials are used to create a paste. The paste then forms a thick coating around aggregate particles, to prevent the flowing off the paste during mixingand placing. Usingenough pasteto coat theparticles to maintain asystem of interconnected voids which allow water and air to pass through. The lack of sand in Previous Concrete results in a very harsh mix that negatively affects mixing, delivery, and placement due to the high void content, Previous Concrete is light in weight. (1600kg/m^3- 2000kg/m^3). Pervious Concrete can be used in a wide range of applications,althoughits primaryuseisin pavementswhich areinresidentialroads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope tennis stabilization, sub-base for conventional concrete pavements etc.

Pervious Concrete system has advantages over impervious concrete in that it is effective in managing run-off from paved surfaces, prevent contamination in run- off water, and recharge aquifer, repelling saltwater intrusion, control pollution in water seepage to ground water recharge concrete and asphalt, reduces the need for air conditioning. Pervious Concrete allows forincreased site optimization because in most cases, it use should totally limit the need for detention and retention ponds, swales and other more traditional storm water management devices that are otherwise required for compliances with the Federal storm water air temperaturewill be reduced, requiring less power to cool the building. In addition, costly storm water structures such as piping, inlets and ponds will be eliminated. Construction scheduling will also be improved as the stone recharge bed will be installed at the beginning of construction, enhancing erosion control measures, and preventing rain delays due to harsh site conditions. Apparently, when 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. Structurally when higher permeability and low strength are required the effect of variation in aggregate size on strength and permeability for the same aggregate cement ratio need to be investigated.

1.2 WHYDOWENEEDPERVIOUSCONCRETE

A large amount of rainwater ends up falling on impervious surface such as parkinglots, driveways, sidewalks, and streets ratherthansockinginto thesoil. This creates an imbalance in the natural ecosystem and leads to a host of problems including erosion, floods, ground water level depletion and pollution of river, lakes, and coastal water as rainwater rushing across pavement surfaces picksupeverything from oil and grease spills to de-icing salts and chemical fertilizers.

A simple solution to avoid theseproblems is to stop constructingimpervious surface that block natural water infiltration into the soil. Rather than building them with conventional concrete or Asphalt, we should be switching toPerviousConcrete or porous pavement, a material that offers the inherent durability of low lifecyclecostof atypicalconcretepavementwhileretainingstorm waterrunoffand replenishing local water shade system. Instead of preventing infiltration of water intothesoil,PerviousConcrete pavement assiststheprocessbycapturingrainwater in a network of voids and allowing it to percolate into the underlying soil. In many cases, Pervious Concrete roadways and parking lots can double as water retention structures, reducing or eliminating the need for traditional storm water management system such as retention ponds, sewer tie-ins.

Pervious Concrete also naturally filters water from rainfall or storm and can reduce pollutant loads entering streams, ponds, and river. So, in this way it helps in ground water recharge.

It also reduces the bad impact of urbanization on trees. A Pervious Concrete ground surface allows the transfer of water and air to root system allowing trees to flourish. For a given rainfall intensity, the amount of runoff from a Pervious Concrete pavement system is controlled by the soil infiltration rate and he water storage capacity available in the Pervious Concrete and aggregate subbase underthe Pervious Concrete. Generally, for a given set of materials, the strength and infiltration rate of Pervious Concrete are a function of concrete density. Greater the density, higher is the strength and lower the infiltration rate.

1.3 OBJECTIVESOFPERVIOUSCONCRETE

The objectives include finding optimal Pervious Concrete mix designs for wearing course sections in pavement applications. Information needed for the wearing course sections must address the issue of noise and skid resistance, assuming adequate strength and durability are developed. Theconstructability issues are also very critical. It is of paramount importance for the research to determine techniques for construction that utilize existing pavement equipment. At present the construction of Pervious Concrete sections is quite labour intensive. The use of Pervious Concrete as a wearing course entails construction of a concrete overlay in rehabilitation efforts. In new construction, two-lift construction is a possibility.

1. PerviousConcretehaslittleornofineaggregate.
2. It has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids.

3. Pervious Concrete is traditionally used in parking areas, areas with light traffic, pedestrian walkways, and greenhouses and contributes to sustainable construction.
4. Itconsists of15%to 35%voids,allowingforquickdrainage.
5. The infiltration rate of pervious concrete will fall into the range of 80 to720 lits/min/sq.m.
6. Tohelprestoregroundwatersupply.
7. Reducepollutionofcostalwater.
8. Topaveparking.
9. Torecharge groundwatertable.
10. Reducesrunoffwater.
11. Reducesriskoffloodingandtopsoilwashaway.

1.4 AIMOF PROJECT

The name of our project is **"Designing and Modeling of Pervious Concrete Pavement."** Thetrend oftodayis to makeimpervious concrete pavement and thus not allowing water to percolate in the ground. These will not only increase the runoff from the road but also reduce virgin land area from where water will recharge the surface. For most of the cities, ground water requirement has declined up to 30m and more observed. In order to tackle the growing problem of ground water level declined, it is necessary to take up for water conservation and artificial recharge to ground water on priority. If impervious concrete pavement constructed, sufficient slope should be given to reach up to the storm drainage line. This will increase amount of concrete/ aggregate in constructing impervious road and forced to increase the capacityof storm water drainage network. To minimize this problem best method is "act locally" i.e. wherever water drops it will reach in that locality only. For these different techniques are available. One of the methods is to construct Pervious Concrete Pavement.

In our Amravati city ground water level has declined to a greater depth. Scenario of today's Amravati is that construction of impervious pavement in every locality, so instead of constructing whole locality with impervious pavement at least walkways, parking lots, etc., or where there is a low traffic area should be constructed with Pervious Concrete pavements, so that it will help in increasing ground water level of Amravati city.

Basically, the aim of our project is to make awareness in people for constructing Pervious Concrete pavement, so that it can be greatly helpful for usand upcoming new generation.

1.5 FUTURISTICSCOPE

1.5.1 Pervious Concrete is a special type of concrete with a high porosity used for concrete flatwork applications that allows water precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge. In India, the issue of urbanization of cities left many metro cities in floods.

1.5.2 For example, floods faced in Mumbai are perfect example of how much Pervious Concrete can be utilized. In Mumbai, due to additional growth of areas, one of the areas where a river which used to takewater out of cityand pour it in sea was blocked. After these, the outcomes were loud and clear. Mumbai faced its worst flood ever which not only handicapped the city but also killed many.

1.5.A Waterlogged concretepavementroad

1.5.3 As the scope of urban cities will increases, Pervious Concrete can provide a solution to this rapid growth of cities. The Pervious Concrete pavement can absorb the noise of vehicles, which creates quiet and comfortable environment.

1.5.4 The Pervious Concrete pavement materials have holes that can cumulate heat. Such pavement can adjust the temperature and humidity of the Earth's surface and eliminates the phenomenon of hot island in cities.

1.5.5 In urban areas larger amount of rainwater ends up falling on impervious surfaces such as parking lots, driveways, sidewalks, and streets rather than soaking into the soil. In future this will creates an imbalance in the natural ecosystem and leads to a host of problems including erosion, floods, ground water level depletion and pollution of rivers, as rainwater rushing across pavement surfaces picks up everything from oil and grease spills to de-icing salts and chemical fertilizers.

1.5.6 Asimplesolution to avoid theseproblems is to stop constructingimpervious surfaces that block natural water infiltration into the soil. Rather than building them with conventional concrete, we should be 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.

1.5.7 Instead of preventing infiltration of water into the soil, Pervious pavement assiststheprocessbycapturingrainwaterinanetworkofvoidsand allowing it to percolate into the

underlying soil.

1.5. B Projectconcreteblock(porosity)

1.5.8 Theoretically the sound absorption properties of a rigid frame porous medium are mainly influenced by void texture and thus the main focus of modelling is to determine the generalized void texture.

1.5.9 Since porous sound absorbing materials, such as polyurethane, fabrics, formed metal, etc. The main concern of the present study is the absorption characteristics of porous concrete in case the vertical incidence acoustic wave has occurred.

1.5.10 Many other type of noise including the rolling noise of vehicles or impact noise with high sound pressure considering random incidence acoustic waves, also need to be considered when designing porous concrete used as an acoustic wall.

1.5.11 However, this issue is beyond the scope of present work, nevertheless, it should be subject of future work for developing more versatile acoustic absorption models for porous concrete.

1.5.12 Therearemanyfactorsthatgiverisetowaterscarcity.Oneofsuchfactorsis the urbanization of areas and decreases in the natural pervious soil area that result in reduced magnitude of the ground water recharge.

1.5.13 As India is facing the problem of water, In future there will be too much shortage of water in world. Groundwater tables and river levels are receding in many parts of the world due to human water use.

1.5.14 In India, farmers are now using nearly80% of the country's available water, largely from groundwater wells. We will have to buy water for drinking purposes. With the help of pervious pavement, we can store rainwater and it can be very helpful in future.

1.5.15 The increasing number of paved roads consequently decreases the area of pervious soil, due to which the ground water table is affected. One-third of the developing world will face severe water shortages in the twenty-first century even though large amounts of water will continue to annually flood out to sea from water-scarce regions.

2. LITERATUREREVIEW

2.1 GENERAL

Literature review of relevant literature published earlier, technical paper by various agencies is carried out. In this literature review attention is given about how newconstructionmateriallikePerviousConcreteisusedforpavement.Thepurpose of this literature review is getting an overview of new construction material like Pervious Concrete by using of different proportions and to know various research studies related to efficient and economic pavement construction, also the compressive strength. To achieve this purpose, study result is given by various authors are mentioned here in this literature review.

2.1.1"Use of Pervious concrete in construction of pavement for improving their performance." Mr. V. R. Patil, Prof. A. K. Gupta, Prof. D. B. Desai. Our cities are being covered with building and the air-proof concrete road more and more. In addition, the environment of city is far from natural. Because of the lack of water permeability and air permeability of the common concrete pavement, the rainwater is not filtered underground. Without constant supply of water to the soil, plants are difficult to grow normally. In addition, it is difficult for soil to exchange heat and moisture with air; therefore, the temperature and humidity of the Earth's surface in large cities cannot be adjusted. Pervious concrete is also widely used in Europe and Japan for roadway applications as a surface course to improve skid resistance and reduce traffic noise. However, the strength of the material is relatively low because of its porosity. The compressive strength of the material can only reach about 20 - 30MPa. The pervious concrete can only be applied to squares, footpaths, parking lots, and paths in parks.[1]

2.1.2 " Pervious Concrete: New Era For Rural Road Pavement". Darshan Shah, Prof. Jayeshkumar Pitroda, Prof. J.J. Bhavsar 2013.Pervious Concrete is a relatively new concept for rural road pavement, with increase into the problems in rural areas related to the low ground water level, agricultural problem. Pervious Concrete has introduced in rural road as a road pavement material. Pervious Concrete as a paving material has seenrenewed interest due to its ability to allow water to flow through itself to recharge groundwaterlevelandminimizestormwaterrunoff.ThisintroductiontoPervious Concrete Pavement reviews its applications and engineering properties, including environmental benefits, structural properties, and durability. In rural area cost consideration is the primary factor which mustbe kept in mind. So that in rural areas costly storm water management practices is not applicable.[2]

2.1.3"Ground water Recharging Through Pervious Concrete Pavement". A. L. Guruji , A.V. Rana, [11 April 2015]The trend of today is to make Impervious Concrete pavement and thus not allowingwatertogointheground. IfImpervious Concretepavementisconstructed, the sufficient slope should be given to reach up to the storm-drainage line. This will increase amount of concrete/aggregate in constructing Impervious Road and forcedto increase the capacity of storm water drainage network. For these different techniques are available. One of the methods is to construct Pervious Concrete pavement. In this paper attempt was to be made to prepare such kind of pavement for road, which recharge water directly into the subsurface. For preparing Pervious pavement, aggregates of different sizes, like 4.75mm to 20mm (coarse aggregate) were used. The proportion of aggregate and cement is 1:3 and tried to find best combination. The specimen prepared with coarse aggregate and cement is tested for compressive strength gives good result. Pervious Concrete not only reduce stormwaterbutalsohelpsinrisinggroundwaterlevelbyartificialrecharging.There is an urgent need to think over the alternative for impervious pavement created for the sake of cleanness and durability. As the concrete is porous its strength gets reduce. In this paper there is attempt to optimize the available resources. Though the strength of concrete reduces due to Pervious property but can be used wherethere is a light load expected.[3]

2.1.4"Some Aspect on Pervious Concrete". R. Selvaraj, M. Amirthavarshini, [January 2016]". The Pervious Concrete is produce byusing materials like cement, aggregate, water and bonding agent. The quantity, proportions, and mixing techniques affect manyproperties of Pervious Concrete, in particular the voids structure and strength. Usually single sized coarse aggregate up to 20 mm sizes are normally adopted. Although the course aggregate size 6mm the 20mm are used, the most common being 10mm fairly uniform size is used.[4]

2.1.5 "PerviousConcrete–Overview"KarthikH.Obla26july 2017". Pervious Concrete is a special high porosity concrete. Concrete mixtures are typically design for 20% void content as there is no significant percolation through the concrete at a void content lower than 15% . There are two factor which determine the design thickness of Pervious pavement, a PerviousConcrete pavement hydraulic properties and

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mechanically properties. ASTM C1701 is standard test method to calculate the infiltration rate of in place Pervious Concrete. To common preventable problems with Pervious Concrete are surface raveling and clogging. These paper gives the idea about Pervious Concrete projects that have been completed over the last 10years in USA and briefly describes about the successful Pervious Concrete in India.[5]

2.1.6 "Design and Construction Of an Experimental Pervious Paved ParkingAreatoHarvestReusableRainwater"ElenaGomez-Ullate,AmayaV.Novo, Joseba R.Bayon Jorge R. Hernandez, R .J. and Daniel Castro-Fresno.2010" Pervious Pavements are sustainable urban drainage system alreadyknown as rainwater infiltration techniques which reduce runoff formation and diffused pollution in cities. This research paper especially focused on the design and construction of an experimental parking area. The methodology of this research focused on the study of water storage and water quality within each Pervious pavement type. Aim of this research paper was to obtain good performance of Pervious pavement that offered simultaneously a positive urban service and help to harvest rainwater with a good quality.[6]

2.1.7 "DeoOmkar,NeithalathNarayanan,"CompressiveStrengthOfPervious Concretes Proportioned For Desired Porosities,"Construction and Building Materials vol. No. 25, 2011,p.p. 4181- 4189. In 2010, OmkarDeo, Neithlath Narayanan studied the properties ofPervious Concrete are strongly dependent on its pore structure features, porosity being and important one among them. Several Pervious Concrete mixtures with different pore structure features are proportioned and subjected to static compression test. The compressive stress-strain response of Pervious Concrete, a model to predict the stress-strain response andits relationship to several oftheporestructure features are outlined. A statistical model was used to relate the compressive strength to the relevant pore structure features. It was observed that a proper understanding of the influence of the pore structure features on compressive response can lead to optimized material design for the desired properties.[7]

3.MATERIALANDMETHODOLOGY

3.1 FLOWCHARTOFPROJECT WORK

Collecting various materials which are required for castinglike aggregates, cement, admixture.

⇩

Casting of 18 Pervious Concrete cubes of (1:3) cement aggregate ratio to be tested at 7 and 28 days.

⇩

Castingof 2 slab Pervious Concrete as (1:3) cement aggregate ratio to betested at 7 and 28 days.

Followingtesttobecarriedout:
Slum conetest.
Compressivestrengthtest.
Permeabilitytest.

⇩

ResultandanalysisofPerviousConcretecubes.

⇩

Foundeffective, hencemodelmaking.

⇩

Resultsoftheproject

Fig.1:Flowchartof work

3.2 MATERIALUSEDINPERVIOUSCONCRETE

3.2.1 CEMENT

The product manufactured by burning and crushing to powder and well proportionmixtureofcalcareousand argillaceous materialiscalledcement.Cement is the key ingredient of the versatile and modern construction material "concrete".

Pozzolana Portland Cement was used for the project work. Pozzolana is a very old construction material which was in Roman times. It does not have any cementingor bindingproperties,butin finelygroundform,it reactwithCa(OH)2to form, compound having cementing properties.

Pozzolana Portland Cement are manufactured by using Pozzolanic materials as one of the main ingredient. The percentage of Pozzolanic material used in the preparationshouldbebetween10%to30%. Ifthepercentageisexceed,thestrength of cement is reduced. Some of the Pozzolanic materialsused are volcanic ash, shales, and certain type of clays. But in our country Fly ash is the main constituents used in the preparation

of cement. And moreover, this type of cement is used more than 80% for construction purposes.

3.2.1.ACement

Table3.1TypicalCompositionOfThePozzolanaPortland Cement

NameofCompound	ChemicalComposition	Abbreviation
TricalciumSilicate	3CaO.SiO2	C3S
DicalciumSilicate	2CaO.SiO2	C2S
TricalciumAluminate	3CaO.Al2O3	C3A
TetracalciumAluminoFerrite	4CaO.Al2O3.Fe2O3	C4AF

The pozzolana constituent must be within 10 to 25%. The mixing of pozzolana component should be very through. Pozzolana Portland Cement can be called a type of low heat cement as it produce low heat of hydration. It has more resistance to attack of aggressive water. It reduces leaching of calcium hydroxide when used in hydraulic structure. Of course, it can be used in all situations wherever OPC can be used.

The new IS code for PPC is 1489-1991 part1. The cement was tested as per IS code provision.

Table3.2Observationsofpreliminarytestingofcement

Test	Fineness	Standard consistency	Initial settingtime	Finalsetting time	Soundness
Standard value	<10	-	Notlessthan 30 min	Not greater than600min	<10
Result	2.22	33%	34min	566 min	4.47mm

ADVANTAGESOFPOZZOLANAPORTLANDCEMENT

(i) Thesecement gainscompressivestrengthwithage.
(ii) Itishighlyresistanceto sulphates.
(iii) Itgivesbetterworkability duringpreparationofconcrete.iv.Itevolves low heat during setting.
(iv) UltimatestrengthismorethanOPC.
(v) Itisresistancetoexpansion.
(vi) Itischeapandaffordable.

(vii)Watertightness.

4.EXPERIMENTALSTUDY

Pervious Concrete uses the same materials as conventional concrete, except that there is usually little or no fine aggregate. The quantity, proportions,and mixing techniques affect many properties of pervious concrete, in particular thevoid structure and strength. Usually, single sized coarse aggregate up to 20 mm size normally adopted. Larger size aggregates provide a rougher concrete finish while smaller size aggregates provide smoother surface that maybe better suited for some application such as pedestrian pathways. Although the coarse aggregate size 6 mm to 20 mm are used, the most common being 10 mm uniform size is used. The aggregates may be rounded like gravel or angular like crushed stone.

Since the Pervious Concrete is highly permeable, the voids between aggregate particles cannot be entirely filled by cement paste. Use of smaller size aggregates can increase the number of aggregate particles per unit volume of concrete. As the aggregate particle increase the specific surface and thus increases the binding area. This results in the improved strength of pervious concrete. However, the major thrust for using Pervious Concrete stems from its capability to drain and potentially de-pollute enormous amounts of water in short time, thus reducing the runoff rates.

In our project we used Pozzolana Portland cement, and admixture Conplast SP430 for casting. To study the behavior of Pervious Concrete pavement, we adopted two different cement to aggregate ratio and different size of course aggregate for gap grading are as follows:

Table4.1Cement/aggregateratioforproportion1:4.5

Sr.No.	PercentageofAggregate	ExperimentalMix
1	60%	20mm
	40%	10 mm
2	100%	10mm
3	100%	6mm

Table4.2 Cement/aggregateratio forproportion 1:3

Sr.No.	PercentageofAggregate	ExperimentalMix
1	100%	20 mm
2	100%	10 mm
3	100%	6 mm

4.1 Casting: Quantity of material used for casting is given below For proportion1:3

Table4.3Quantityofmaterials(1:3)

Sr.No.	Materials	Proportions(kg/m^3)
1	Cement	395.4
2	Aggregate	1738.44
3	Watercementratio	0.3
4	Admixture	20ml per50kg

Casting of cubes

Table4.4 Quantity of materials(1:3)

Sr.No.	Materials	Proportions(kg/ m3)
1	Cement	543.18
2	Aggregate	1629.54
3	Water Cement ratio	0.3
4	Admixture	20ml per 50kg

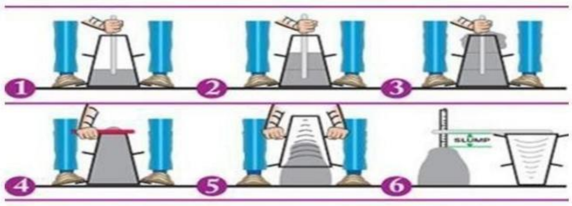
4.2 TESTING

4.2.1 Slump Cone Test

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to checkthe workabilityof freshlymadeconcrete,and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for differentloads of concrete under field conditions.

Procedure

The test is carried out using a metal mould in the shape of a conical frustum known as a slump cone or Abramscone, that is open at both ends and has attached handles.Thetool typicallyhas an internal diameterof100 millimeters (3.9in)at the top and of 200 millimeters (7.9 in) at the bottom with a height of 300 millimeters (12.0 in). the cone is placed on a hard non-absorbent surface. This cone is filledwith fresh concrete in three stages. Each time, each layer is tamped 25 times with a2 ft (600 mm)-long bullet-nosed metal rod measuring 5/8in (16 mm) in diameter. At the end of the third stage, the concrete is struck off flush with the top of the mould. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone. The concrete then slumps (subsides). The slump of the concrete is measured by measuring the distance from the top of the slumped concrete to the level of the top of the slump cone.



4.2.1 (a) Diagrammaticalrepresentationofslumpconetestprocedure

The slumped concrete takes various shapes and according to the profile of slumpedconcrete,theslumpistermedas trueslump,shearslumporcollapseslump. If a shear or collapse slump is achieved, a fresh sample should be taken and the test repeated. A collapse slump is an indication that the mix is too wet.

Only a true slump is of any use in the test. A collapse slump will generally meanthatthemix istoo wetor thatitis ahigh workabilitymix,for whichtheslump test is not appropriate. Very dry mixes having slump 0– 25 mm are typically used in road making, low workabilitymixes having slump 10 – 40 mm are typicallyused for foundations with light reinforcement, medium workabilitymixes with slump 50 – 90 mm, are typically used for normal reinforced concrete placed with vibration, high workability concrete with slump > 100 mm is typically used where reinforcing has tight spacing, and/or the concrete has to flow a great distance.

4.2.1 (b) Castingofslumpcone

4.2.2 CompressiveStrengthTest

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. Bythis single test one judge that whetherConcretinghas been done properly or not. Concrete compressive strength for general construction varies from 3 MPa to 28 MPa. Compressive strength of concrete depends on many factors such as water- cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test.thesespecimensaretestedby compressiontestingmachineafter7dayscuring or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Loadat the failure divided by area of specimen gives the compressive strength of concrete.

SamplingofCubesforTest

i) Clean the mounds and applyoil
ii) FilltheconcreteintheMoldsinlayers approximately5cm thick
iii) Compacteachlayerwith notlessthan25strokesperlayerusingatamping rod (steel bar 16mm iv) diameter and 60cm long, bullet pointed at lower end)
iv) Levelthetopsurface andsmoothenit withatrowel Curingof Cubes.

CuringofCubes

The test specimens are stored in moist air for 24 hours and after this period thespecimens aremarked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

ProcedureforCubeTest

(I) Removethespecimenfromwaterafterspecifiedcuringtimeandwipeout excess water from the surface.
(II) Takethedimensionofthespecimento thenearest0.2m.
(III) Cleanthebearingsurfaceofthetestingmachine.
(IV) Placethespecimeninthemachineinsuchamannerthattheloadshallbe applied to the opposite sides of the cube cast.
(V) Alignthespecimencentrallyonthebaseplateofthemachine.
(VI) Rotatethemovableportiongentlybyhandsothat ittouchesthetopsurfaceof the specimen.
(VII) Applytheload graduallywithoutshockandcontinuouslyattherateof140 kg/cm2 /minute till the specimen fails.
(VIII) Recordthe maximumload andnote anyunusual featuresinthetypeof failure.

CompressiveStrengthofConcreteatVariousAges.

The strength of Pervious Concrete increases with age. Table shows the strength of concrete at different ages in comparison with the strength at 28 days after casting.

Table4.5strengthof concrete

Age	Strengthpercent
1 day	16%
3days	40%
7days	65%
14days	90%
28days	99%

4.2.3 PermeabilityTest

The permeability of pervious concrete was determined using a falling head Permeability set up Figure. 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 5seconds 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:

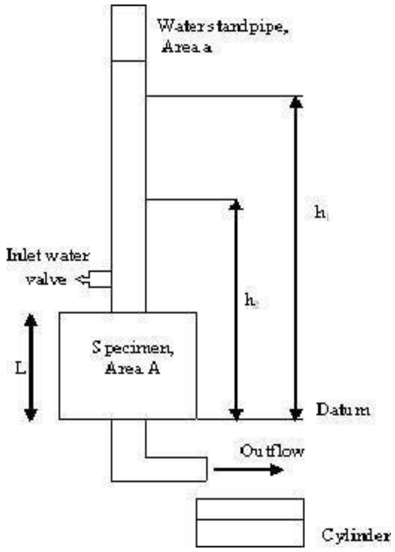


Fig.1VariableHeadPermeabilityTestApparatus

Where,

a=the samplecrosssection are
A=thecrosssectionofthestandpipeofdiameter(d)=0.95cm2 L = the height of the pervious concrete
(t2-t1)=changeintimeforwatertofallfromonelevelto another (5secs.)
h1 = upper water level h2=Lowerwaterlevel
D = diameter of sample (10.5cm)
d=diameterofstandpipe (1.1cm)

4.2.3.APermeabilitytestingon20mmsizeslab

4.2.3.BPermeabilitytestingon10mmsizeslab

4.2.3.CPermeabilitytestingon6mmsizeslab

4.2.4 Flexuralstrengthtest

Directmeasurementoftensilestrengthofconcreteisdifficult.Neither specimens nor testing apparatus have been designed which assure uniform distribution of the pull applied to the concrete. While number of investigation involve the direct measurement of tensile strength have been made ,beam tests are found to be dependable to measure flexural strength properly of concrete. The flexural strength is found in form of modulus of rupture. The system of loadingused in finding out tension is central point loading and third point loading.

Thestandard sizeofspecimen is 15x15x70cm.Themould should be metal preferably steel or cast iron and metal should be of sufficient thickness to prevent spreadingorwarping. The bed oftestingmachine should

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beprovidedwith two steel rollers, 38mm in diameter. The load is applied axially and without subjecting specimen to any torsional stresses.

Thetestspecimenstored inwaterattemperatureof24ºcto30ºcfor48hours before testing Test the specimen immediately on removal of from water whilst they still in wet condition. The axis of specimen carefully aligned with axis of loading device. The load is applied without shock and increasing continuously at the rate of 0.7kg/sq.cm./min.Theloadisincreaseduntilthespecimenfails,andmaximumload applied to specimen during test is recorded. The flexural strength of specimen is expressed in modulus of rupture as-

Where,

b=widthofspecimenincm.

d =depth of specimen in cm.

p =maximumload applied in kgto specimen

a=distancebetweenthelineoffractureandnearersupport,measuredon centerline of tension side of specimen.

4.2.4Flexuralstrengthtestingonslab

4.2.5 Splittensilestrengthtest

This test was developed in Brazil in 1943.This is also referred as, "Brazilian Test". The test is carried out by placing the cylindrical specimen horizontally between the loading surfaces of a compression testing machine. The size of specimen is 150 mm in diameter and 300 mm in depth. The load is applied until specimen fail along vertical diameter.

The loading condition produces a high compressive stress immediately below the two generators to which is applied. But larger portion corresponding to depth is subjected to uniform tensile stress acting horizontally. It is estimated that compressive stress acting about D/6 depth and remaining depth is subjected to tension. In order to reduce the magnitude of compressive force near point of application of the load, narrow packing strips of suitable material such as plywood are placed, to distribute the load economically.

The main advantage of this test is same type of machine can be used performed both compression test as well as tensile test. This test givesmoreuniform results than another test. Strength determined in the splitting tensile strength test is believed to be closer to true tensile strength of concrete than modulus of rupture.

5. RESULTSANDDISCUSSION

5.1 PropertiesofcementtestedatConcretetechnologylaboratory.

Table5.1.1Cementtestobservation

Sr.No.	Properties	Value
1	Fineness	2.22
2	Standardconsistency	33%
3	Settingtime a) Initialsettingtime b) Finalsettingtime	 34 min 566 min
4	Soundness	4.47 mm

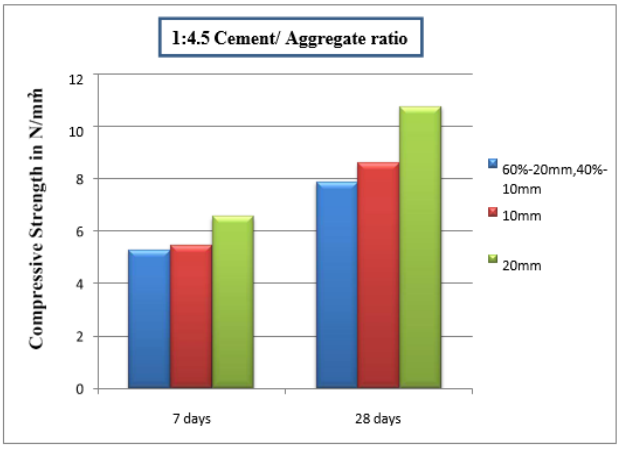
5.2 Compressivestrengthtestresults

Table 5.2.1Compressivestrengthfor7Days(1:4.5)

Sr.No	Cement/ Aggregate ratio	% of aggregate	Size of aggregate in mm	Strength 7 Days			
				Sample 1	Sample 2	Sample 3	Avg N/mm²
1	1:4.5	40% 60%	10 20	5.636	5.411	4.786	5.277
		100%	10	5.421	5.896	5.092	5.469
		100%	20	6.941	7.034	5.726	6.567

Table5.2.2Compressivestrengthfor28Days(1:4.5)

Sr. No	Cement/ Aggregate ratio	% of aggregate	Size of aggregate in mm	Strength 28 Days			
				Sample1	Sample2	Sample3	Avg N/mm²
1	1:4.5	40% 60%	10 20	8.052	8.228	7.364	7.880
		100%	10	9.856	8.800	7.172	8.609
		100%	20	10.29	12.584	9.372	10.75



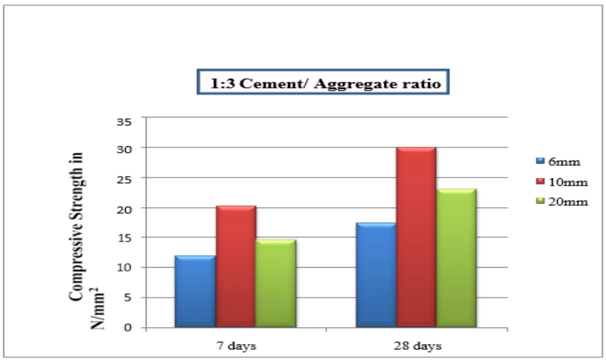
Graph 5.2.1for1:4.5cement/aggregateratio

Table 5.2.3Compressivestrengthfor7days(1:3)

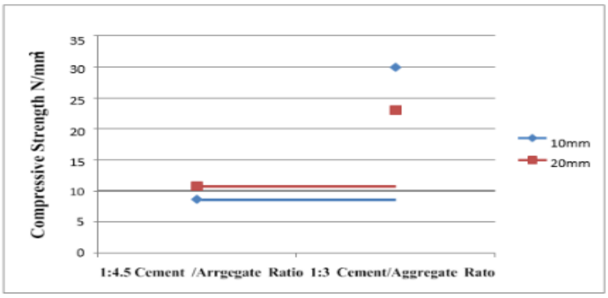
Sr.No	Cement/ Aggregate ratio	% of aggregate	Size of aggregate in mm	Strength 7 Days			
				Sample1	Sample2	Sample3	Avg N/mm²
1	1:3	100%	6	13.662	11.206	10.918	11.931
		100%	10	19.999	18.438	22.207	20.214
		100%	20	14.209	15.977	13.475	14.546

Table 5.2.4Compressivestrengthfor28days(1:3)

Sr.No	Cement/ Aggregate ratio	% of aggregate	Size of aggregate in mm	Strength			
				28 Days			
				Sample1	Sample2	Sample3	Avg N/mm²
1	1:3	100%	6	18.216	17.24	16.676	17.380
		100%	10	30.58	29.740	29.612	29.977
		100%	20	21.860	22.792	24.50	23.050



Graph5.2.2For1:3cement/aggregateratio



Graph5.2.3Comparisonofcompressivestrengthfordifferentratio

5.3PermeabilityTestResult

Table6.4Permeabilitytestresultforvariouslayersofslab

Sr No.	Size of aggregate in slab	Input	Output	Timetaken	Permeabilityin cm/sec
1	20mm	11 lit	10 lit200 ml	34 sec	39.85
2	10mm	11 lit	9 lit 700 ml	68 sec	9.094
3	6mm	11 lit	9 lit 200 ml	102 sec	1.157

Calculation of Permeability

$$\text{Formula: } K = \frac{2.303aL}{A(t_2-t_1)\times\log\left(\frac{h_1}{h_2}\right)}$$

Where,
a=Samplecross-section area,
L=Heightofthepervious concrete
A=Cross-sectionofthestand pipe ofdiameter(d)

h_1= Upper water level
h_2= Lower water level
D= Diameter of sample
d=DiameterofStandpipe
(t_2-t_1)=Changeintimeforwatertofallfromoneleveltoanother.

CONCLUSION

Pervious concrete reduces storm water runoff ultimately increases the capacityof rainwater harvesting system. It also helps to increase the ground water level, to eliminate the costly storm water management practices and compensate extractionof water either in village or city. From results it found that Pervious concrete prepared with all 20 mm size aggregate has maximum compressive strength for 1:4.5 Cement/Aggregate ratio, while Pervious concrete prepared with all 10 mm size aggregate has maximum compressive strength for 1:3 Cement/Aggregate ratio.

Pervious concrete prepared with combination of 10 mm and 20 mm size aggregatehasmoretensilestrengthfor1:4.5Cement/Aggregateratioandfor1:3 Cement/Aggregate Pervious concrete prepared with all 20 mm size aggregatehas maximum tensile strength.AdditionofCONPLASTSP430acceleratesthestrengthofgainatearlyageand improves workability of concrete without increasing water demand. Using singe size of aggregate for casting pervious concrete gives good permeability. Using singe size of aggregate for casting pervious concrete gives good permeability. Thepermeabilityvalue ofwholemodel isfoundto be1.41 cm/hr. It is found that Pervious Concrete have less strength than conventional concrete. Hence, it is used for roads having low intensity of traffic. Void ratio and compressive strength of Pervious Concrete are inversely proportional to each other with increase in voids compressivestrengthdecreases. Pervious Concrete pavements are a very cost-effective and environmentally friendly solution to support sustainable construction.

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