International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

HDPE Plastic based Pervious Concrete

AZAM AHMAD- (2100970009007)
MOHAMMAD AQIB KHAN- (2100970009012)
MOHAMMAD SAMEER GUL- (2100970009013)
MUDASSIR SHAMIM- (2100970009014)

Under the supervision of **DR. AKASH MALIK**
Department of Civil Engineering
GALGOTIAS COLLEGE OF ENGINEERING & TECHNOLOGY

Abstract

Pervious concrete is a special type of concrete, which consists of cement, coarse aggregates, water and if required, admixtures and other cementations materials. 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 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 porosity and voids. Hence, the usage of previous 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 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.

Keywords :-

CEMENTITIOUS MATERIALS , NO FINES, HDPE P AGGREGATES, PERVIOUS CONCRETE, POROUS CONCRETE

Introduction :-

Pervious concrete which is also known as the no- fines. Porous, gap-graded, and permeable concrete and Enhance porosity concrete have been found to be a reliable storm water management tool. By definition, pervious concrete is a mixture of gravel or granite stone, cement, water, little to no sand (fine aggregate). When pervious concrete is used for paving, the open cell structures allow storm water to filter through the pavement and into the underlying soils.

Pervious concrete is also a unique and effective means to address important environmental issues and sustainable growth. When it rains, pervious concrete automatically acts as a drainage system, thereby putting water back where it belongs. Pervious concrete is rough textured, and has a honeycombed surface, with moderate amount of surface raveling which occurs on heavily travelled roadways.

Carefully controlled amount of water and cementitious materials are used to create a paste. The paste then forms a thick coating around aggregate particles, to prevent the flowing off of the paste during mixing and placing. Using enough paste to coat the particles maintain a system of interconnected voids which allow water and air to pass trough. The lack of sand in pervious concrete results in a very harsh mix that negatively affects mixing, delivery and placement. Also, due to the high void content, pervious concrete is light in weight (about 1600 to 2000 Kg/m3).

Pervious concrete can be used in a wide range of applications, although its primary use is in pavements which are in: residential roads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope stabilization. Sub- base for conventional concrete pavements etc.,,

1.1 Objective -

To investigate the performance characteristics of the pervious concrete such as porosity, compressive strength, infiltration rate.

1.2 Brief History -

Pervious concrete has been around for hundreds of years. The Europeans recognized the insulating properties in structural pervious concrete for their buildings. Europeans have also used pervious concrete for paving.

Pervious concrete was first used in 1852. Pervious concrete has been employed in European countries since the nineteenth century.

The earliest usage of pervious concrete in modern history was for two houses in England. Over 900 houses were built from 1942.

Most of the houses using pervious concrete are in the United Kingdom (ACI 522 Pervious concrete, 2006).

1.3 General properties of pervious concrete -

The plastic pervious concrete mixture is stiff compared to traditional concrete. Slumps, when measured, are generally less than 20mm, although slumps as high as 50mm have been used. However, slump of pervious concrete has no correlation with its workability and hence should not be specified as an acceptance criterion. Typical densities and void contents are on the order of 1600 Kg/m3 to 2000 Kg/m3 and 20% to 25% respectively.

In contrast the steady state infiltration rate of soil ranges from 25 mm/hr to 0.25 mm/hr. this clearly suggests that unless the pervious concrete is severely clogged up due to possibly poor maintenance it is unlikely that the permeability of pervious concrete is the controlling factor in estimating runoff (if any) from a pervious concrete.

1.4 Benefits of pervious concrete -

Pervious concrete pavement systems provides a valuable storm water management tool under the requirements of the EPA storm water phase 11 final rule phase11 regulations provide programs and practices to help control the amount of contaminants in our waterways. Impervious pavement particularly parking lots collect oil, anti-freeze, and other automobile fluids that can be washed into streams, lakes, and oceans when it rains.

EPA storm water regulations set limits on the levels of pollution in our streams and lakes. To meet these regulations, local officials have considered two basic approaches. They are

1. Reduce the overall runoff from an area
2. Reduce the level of pollution contained in runoff

1.5 Major applications of pervious concrete -

- **Low-volume pavement**
- Residential roads, alleys, and driveways
- Sidewalks and pathways
- Parking areas
- Low water crossings
- Tennis Courts
- Slope Stabilization
- Well Innings
- Hydraulic Structures
- Swimming pool decks

Literature Review

1 . Karrktk II. Obla (2010): Pervious Concrete: An Over view. flatwork applications that allows water from precipitation Pervious concrete is a special high porosity concrete uBed for and other Bouncesto pass through, thereby reducing the runoif from a site and recharging ground water levels. Its void .content ranges from 18 to 35%

with compressive strengths of 400 to4000 psi (28 to 281 kg/cm2). The infiltration rate of pervious concrete will fall into therange of 2 to 18 gallons per minute per square foot (80 to 720 lit per minute per squaremeter). Typically, pervious concrete has little or no fine aggregate and has just enoughcementitious paste to coat the rourse aggregate particles while preserving the intereonnectivity of the voids

2 . Javier Castro 2010: This has mainly to the use of pervious concrete in place of conventional concrete. Pervious concrete has been used as an egective method for handling and reducing negativeenvironmental impacts. The voids are createB in the concrete for passing the water fromconcrete, also reducing the problem of water logging and make a road surface Bkidrears- tance and increasing the water table, The performance of pervious concrete was compared with the material used for the construction of concrete road pavements. t wasfound that Pervious concrete pavements possesses some positive features like increasedskid resis- tance and high permeability. Pervious concrete has proven to have propertiessuitable for use in low volume traffic areas. If pervious concrete pavements canbeimplemented, it will have various positive effects on the environment.

3 . Md, Abid Alam and Shagufta Naz(2015): The purpose of thia project is to analyse the feasibility of producing highly sustainable nofine concrete mixtures and evaluating the effect of fine aggregate on their properties. No- fine concrete is produced by using ordinary Portland cement, coarse aggregates, andwater. This concrete is tested for its properties, such as slump value, porosity andcompressive strength The results showed that porosity hab significant e8ect oncompreBsive strength of no-fine concrete. Replacement of coarse aggi'egate with fine aggregate upto20%had significant effect on the porosity and cornpre.ssive strength of the no-fine concrete.

4 . hlohammed Sonebia, Lfohamed Bassuonib, Ammar Yahiacin 2016: This type of porous Concrete can help minimizing flooding risks, rechargінggroundwater table, reducing runoff and peak flows, and improving water quality. Inaddition, PCPC can be reduce the absorption of solar radiation power and urbanheat storage Potential which can lead to temperate urban conditions, in which protecting theenvironment Rnd health and safety of living things. This increases the potential for excess Surface run off, which can lead to dowIlBtream flooding, bank andcontrol thepollution.

5. Menninger Studied the effect of different aggregate sizes (10 mm and 20 mm) on hardened properties of non-fine concretes and the results showed that compressive strength reduces with increase in aggregate size.

- **Materials of pervious concrete**

1.Cement -

• Ordinary Portland cement (OPC) of grade 53.

• As per BIS requirements the minimum 28 days compressive strength of 53 grade OPC should not be less than 53 Mpa.

2. Coarse aggregates -

• Coarse aggregates of size 20 mm.

• Recent studies have also found that pervious concrete with smaller aggregate had higher compressive strength.

3. Water -

• Water- to –cement ratios can range from 0.27 to 0.30 with ratios as high as 0.40.

• Carefully control of water is critical.

4. Fine HDPE Plastic –

HDPE fines are tiny particles of high-density polyethylene, a strong and durable plastic. They are byproducts of manufacturing processes like grinding or shredding. These fines can be recycled and reused in producing new plastic items, though handling them can be tricky due to their small size and potential dust issues. Proper management is crucial to avoid environmental harm.

Mix Design

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 affects many properties of pervious concrete,In particular the void structure and strength. Usually single sized Coarse Aggregates upto 20mm size normally adopted.The Binder normally used in Ordinary Portland Cement (OPC). Pozzolanic Materials like Fly Ash,Blast furnace And Silica Fume can also be used.However Use of these materials will affect Setting Time, Strength, Porosity and Pemeability Of the Resulting Concrete. Additional of Fine Aggregate (HDPE Plastic) will reduce the porosity and Increase the strength of Concrete.

MIX DESIGN	CEMENT(KG)	PERCENTAGE	AGGREGATE(KG)	PLASTIC(KG)	RESULT
M20	1.36	0	7.0875	0	21.06 Mpa
	1.36	10	7.0875-0.708=6.3795	0.269	23.45 Mpa
	1.36	20	7.0875-1.4175=5.67	0.538	21.77 Mpa
	1.36	30	7.0875-2.126=4.961	0.808	18.81 Mpa

Preparation and Curing

The preparation process involved thoroughly mixing the dry materials (Cement, coarse, and fine HPDE aggregates). The resulting Paste was poured into Mould and Cured for 28 days.

Test Conducted

.

1. Compressing Testing Machine

Conduct compressive strength tests on pervious concrete specimens using a compression testing machine following ASTM C1688 or ASTM C39.

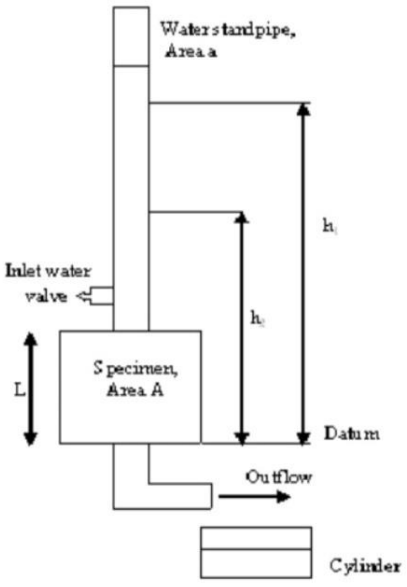
Results and Discussion

Table 4. Compressive Strength

Sr.No.	Property	Curing Period	% of HDPE Plastic powder	Compressive Strength
1	Normal	28 days	0%	21.06 Mpa
2	Normal	28 days	10%	23.45 Mpa
3	Normal	28 days	20%	21.77 Mpa
4	Normal	28 days	30%	18.81 Mpa

2. Permeability test on pervious concrete-

The permeability of pervious concrete was determined using a falling head permeability set up figure in below:



Formula: **K=2.303Al/a (t2-t1) log (h1/h2)**

Where,

a= the sample cross section area

A=the cross section of the standpipe of diameter (d) =0.95 cm2

L=the height of the pervious concrete

h1=upper water level

h2=lower water level
D=diameter of sample (10.5 cm)
d=diameter of standpipe (1.1 cm)

Result And Discussion-

Table 4.4 Coefficient of Permeability

Sr.No.	Property	Curing Period	% of HDPE Plastic powder	Permeability
1	Normal	28 days	0%	1.02 cm/sec
2	Normal	28 days	10%	0.79 cm/sec
3	Normal	28 days	20%	0.69 cm/sec
4	Normal	28 days	30%	0.567 cm/sec

Conclusion

1. The size of coarse aggregate, w/c ratio and aggregate to cement ratio plays acrucial role in strength of pervious concrete.

- The void ratio and unit weight are two important parameters of perviousconcrete in context of mix design.

2. The compressive strength and co efficient of permeability of pervious concreteare inversely proportional to each other up to addition of 20% fines.

3. The addition of fines and replacement of coarse aggregate will reduce thepermeability capacity of pervious concrete.

4. The compressive strength of pervious concrete is increased by maximum 11.34%, when 10% fines are added to standard pervious concrete.

5. The compressive strength of pervious concrete increased by 3.4% inreplacement of 20% of coarse aggregate with fine plastic powder.

6. The compressive strength of pervious concrete decrease by 10.67% inreplacement of 30% of coarse aggregate with fine plastic powder as comparedto standard pervious concrete.

7. The maximum compressive strength is attained when 10% of fine powder issubstituted with coarse aggregate.

8. The compressive strength of pervious concrete has 23.45 Mpa when 10% fineplastic powder is added in replacement of coarse aggregate. It is higher than thestandard pervious concrete without any replacement of 21.06 Mpa after 28 days.

9. Maximum amount of coefficient of permeablity of 1.02 cm/sec has occurred forstandard pervious concrete with 0% fine.

10. The coefficient of permeability has decreased to a minimum of 0.567 cm/secwhen 30% fines are added to standard pervious concrete.

11. The replacement 30% fines in total coarse aggregate gave least value of coefficient of permeability due to reduction in voids as volume of fine decreased..

12. Hence it is recommended that replacement of 10% of fine plastic powder with coarse aggregate to the pervious concrete will satisfyboth the compressive strength and permeability of pervious concrete

Future Work

. In the past due to the scarcity of cement, the pervious concrete has been used extensively.

• The pervious concrete has lost its importance after successful production of cement in large quantities.

• But now a day, the usage pervious concrete has gained its popularity due to many advantages.

• The urban areas all over the world have become CONCRETE JUNGLES. The discharge of storm water is very difficult problem in the present conditions.

• By using the pervious concrete we can able to recharge the ground water table and the storm water disposal can also be done.

• So, in future to tackle aforesaid problems and to protect people from flood prone areas, the pervious concrete is one effective solution.

ACKNOWLEDGEMENT

We are grateful to our guide DR. Akash Malik , Assistant professor, for having given us the opportunity to carry out this project work. We would like to thank Dr.Rishav Garg, professor and Head of the department of CIVIL ENGINEERING, for valuable suggestions throughout my project which have helped in giving definite shape to this work.

References :-

1. Ghafocri N. and Dutta (November 1995). ”Building and Non pavement Applications of No-Lines Concrete," Journal of Materials in Civil Engineering, Volume 7, Number 4, G B . 286-289.

2. M. S. Shetty ”Concrete Technology" S. Chond and Co.Ltd.(1997). IS 516- 1959. ”Methods of Tests for strength of concrete", Bureau of Indian Standards, NewDelhi.

3. Dr.I.d.Magdum etl., ”Jaysingpu(r2000) Use Of Pervious ConcreteInCOIlBt£aftiOIl Of Pavement For Improving Their Performance", OSR Journal of Mechanical and Civil En- gineering ISSN:2278-1684, PP:54-56.

4. ling Yang and Guoliang Jiang. (2003). Experimental study on properties of pervious concrete pavement materials. Cement and Concrete Research, 33 , 381 386.

5. Klieger et al. (2003),Performed experiments studying the effects of entrained air onthestrength and durability of conventional concrete.

6. Sung-Bum Parks and Mang Tiab. (2004). An experimental study on the waterpurification properties of porous concrete. Cement and Concrete Research, 34, 177-184.

7. M. Aamer Rafique Bhuttaa, K. Tsuruta b, J. Mirza (2005), was studied on topic of Evaluation of high-performance porous concrete properties. The aim of this laboratorystudy was to evaluate the properties of high performance porous concrete.

8. Chetan Hazaree and Dr.Ha1il Ceylan. (2006). High volume Fly ash concrete for pavement applications with gap graded aggregates: Marginal and fine sandB. Airfield andHighway Pavements, pp.52&542.

9. Baoshan Huang, Hao Wu, Xiang Shu and Edwin G. Burdettc. (2010). Laboratoryevalu- ation of permeability and strength of polymer-modified pervious concrete. Construction and Building materials , 24, 818-823.

10. Javier Castro 2010,This haa mainly to the use of pervious concrete inplace of conventional concrete.

11. C. Lian, Y. Zhuge and S. Beecham. (2011). The relationship between porosityand strength for porous concrete. Construction and Building Materials, 25, 4294 4298.

12. Cheng, Hut-Mi Hsu, Sao-Jeng Chao and Kae-Long Lin. (2011). Experimental Study on Properties of Pervious Concrete Made with RecycledAggregate. Internal Journal of Pavement Research and Téchnolpgy, 4,N0.2,104-110.

13. Bradley J. Putman and Andrew I. Neptune. (2011). Comparison of test specimen preparation techniques for pervious concrete pavements. Construction and Building MaterialB, 25,34803485.

14. G.GirishandR.Manjunath Rao. (2011). A step towards mix proportioning guidelines for pervious concrete . International Journal of Earth ScienCee and Engineering, 4, 768 -771.

15. Milani S. Sumanasooriya and Narayanan Neithalath. (2011). Pore structure features of pervious concretes proportioned for desired porositieB and their performance prediction. Cement and Concrete Composites, 33, 778-787.

16. Xiang Shu , Baoshan Huang, Hao Wu, Qiao Dong and Edwin G. Burdette. (2011). Performance compariaon of laboratory and field produced pervious concretemixtures. Construction and Building Materials, 25 ,3187 3192.

17. M. Aanicr Rafique Bhutta , K. Tsuruta and J. Mirza. (2012). Evaluation of high- performance porous concrete properties. Construction and Building Materials 3167 73.

18. Yu Chen,Kejin Wang,Xuhao Wang and Wenfang Zhou. (2013). Strength, fractureand fatigue of pervious concrete. Coliatruction and Building Materials, 42, 97-104

19. M. Harshavarthanabalaji M.R.Amarnaath,(February 2015)"Design Of Eco friendly Per- vious Concrete"International Journal Of Civi engineeringAnd Technology (ljciet) Volume Issue 2, Pp. 22-29.

20. Md. Abid Alam and Shagtifta Nas(2015),Thc purpose of this project is toanalyse the feasibility or producing highly sustainable no-fine concrete mixtures andevaluating the effect offine aggregate on their properties. 21. Mohammed Sonebia, Mohamed Bassuonib, Ammai Yahiacin 2016,This type of porous Concrete can help minimizing dooding risks, recharging groundwater table, reducing runoif and peak flow's, and improving water quality