Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 07, pp.34816-34819, July, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EXPERIMENTAL INVESTIGATION ON INCREASING THE STRENGTH OF PERVIOUS CONCRETE BY VARYING THE MIX INGREDIENTS

***Arun, H., Franglin Jose, L., Joegin Raj, K. R., Julius Walter, A. G. and Mr. M. Murugalingam**

Department of Civil Engineering, Loyola Institute of Technology

ARTICLE INFO

Article History:
Received 05th May, 2016
Received in revised form
14th June, 2016
Accepted 10th July, 2016
Published online 31st July, 2016

Key words:

Pervious Concrete, No Fineness concrete, Water drain, Ground water improvement.

ABSTRACT

Pervious concrete or No fineness concrete is a conventional concrete that is used in pavement or car parking's for draining of storm water and increasing the ground water level. This project is mainly based on the investigation and increasing the strength characteristics of Pervious concrete. The mix design is designed considering only cement and coarse aggregate since the concrete is a "NO FINENESS CONCRETE". The mix ratio is considered as 1:6 and the water cement ratio is taken from 0.4-0.45. The admixtures are added in % of cement for Nano silica & % of concrete for polypropylene. The final outcome to be received is increase in the strength of pervious concrete by improving their characteristics and make them utilized for Road pavements.

Citation: Arun, H., Franglin Jose, L., Joegin Raj, K. R., Julius Walter, A. G. and Mr. M. Murugalingam, 2016. "Experimental investigation on increasing the strength of pervious concrete by varying the mix ingredients", *International Journal of Current Research*, 8, (07), 34816-34819.

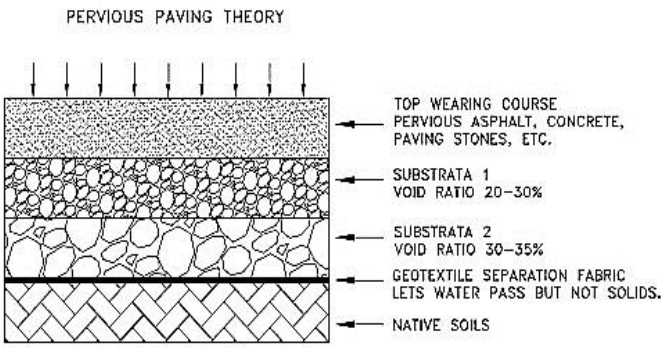
INTRODUCTION

Water logging and depleting ground water table are the two major problems faced by the people all over the world. Even though some places have very well planned drainage facilities it becomes difficult sometimes to drain water from road surfaces. In modern times due to increasing population in developing countries like India the exposure of soil surface to the nature is highly reduced because of increased construction activities. Urbanization reduced soil surface exposure on the top earth surface which is often being covered by a layer of Tar or Concrete for roadway. The ground water level is also reducing due to low rate of infiltration and also the run-off water is generally high. Pervious concrete is one of the modern methods which is highly capable of draining water and also has low strength characteristics. Implementation of pervious concrete roads for Indian conditions is very essential for a beneficial town planning with efficient collection system for run-off water. Pervious concrete is a zero-slump, open graded material consisting of hydraulic cement, coarse aggregate, admixtures and water.

**Corresponding author: Arun, H.*
Department of Civil Engineering, Loyola Institute of Technology

Advantages

- Recharge of local aquifer
- Water budget retention and pollution removal
- Less need for storm sewer
- Green building alternative suitable for many applications
- Natural run-off allows rainwater to drain directly to sub-base



Future scope of the project

- Pervious concrete can be used as pavements or pathway in high rise apartments to increase the ground water and

also it can be used in the sides of highway pavements to save run off water
- Implementation of pervious concrete is village roads can be very useful in storm draining system and storing of storm water for agriculture
- This system can also be useful for devising storm draining system in cities by providing pathway for draining and collection of storm water by means of special system
- Implementation of these road for Indian conditions is very essential for a beneficial town planning with efficient collection system for run-off water

Materials used

General pervious concrete consists of only Cement & Coarse aggregate. Cement is the only binder material used in the project and hence OPC53 grade cement is used. Coarse aggregate size of 15mm to 25mm is used in the project to obtain maximum permeability. Apart from Cement and Aggregate admixtures such as Nano-Silica and Polypropylene are used in this project to increase the Compressive strength and abrasion strength of pervious concrete. Nano silica is added in 5% to 15% weight of cement particles. Polypropylene fibers are used with the concrete and sheets are shredded into pieces and are mixed with concrete.

Properties of nano silica

- Particle size = 17 Nano
- SiO_2 content = 99.88%
- Tamped density = 44g/l
- pH value = 4.12
- Specific surface area = 202m2/g
- Carbon content = 0.06%
- Chloride content = 0.009%
- Loss on Drying @ 105 Deg.C = 0.47
- Sieve Residue = 0.02

Properties of polypropylene

Density	**/ kgm-3**	**905**
Tensile Strength	/ Mpa	33
Tensile Modulus	/ Gpa	1.4
Elongation at Break	/ %	150
Hardness	/ Rockwell "R" Scale	90
Heat Distortion Temp (HDT)	@ 0.45 MPa / °C	105
Heat Distortion Temp (HDT)	@ 1.80 MPa / °C	65
Volume Resistivity	/ logÙm	19
Oxygen Index	/ %	17

Mix design

Due to the absence of fine aggregate the general design mix is considered as per IS standards from 1:5 to 1:10. The mix ratio of 1:6 is considered to be the mix which yields maximum strength i.e., 1 part of cement and 6 parts of coarse aggregate.

Totally 3 design mix were used such as

- Plain Pervious concrete
- Pervious concrete with Nano Silica
- Pervious concrete with Nano Silica and Polypropylene

	Mix 1	Mix 2	Mix 3
Mix Ratio	1:6	1:6	1:6
Water Cement Ratio	0.45	0.4	0.4
Weight of Admixtures	NA	1.25kgs	8.75 kgs+1.34kgs

Mixing methods for admixtures

Nano silica

Clearly mixing the Nano-Silica with cement. Then mixing the Combination with Aggregate and mixing using adequate water.

Polypropylene

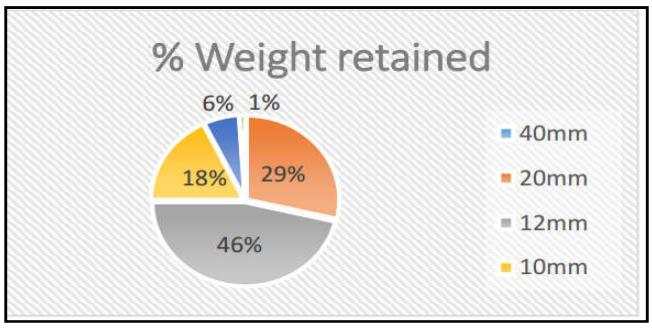
- Mixing partial proportions of polypropylene fibers and sheet pieces with cement and coarse aggregate in equal ratios
- Then mixing those 2 ingredients with adequate amount of water.

Material testing results

Sieve analysis

Specific gravity of coarse aggregate is found to be 2.8 and as per IS 2386 (part3):1963, the specific gravity of coarse aggregate should be 2.6 to 2.9.

- % of water absorption of coarse aggregate= 3.5 %
- The specific gravity of cement obtained is 3.08.
- Fineness of cement = 1%
- The percentage of water required for obtaining cement paste of standard consistency = 22.5%



Testing results

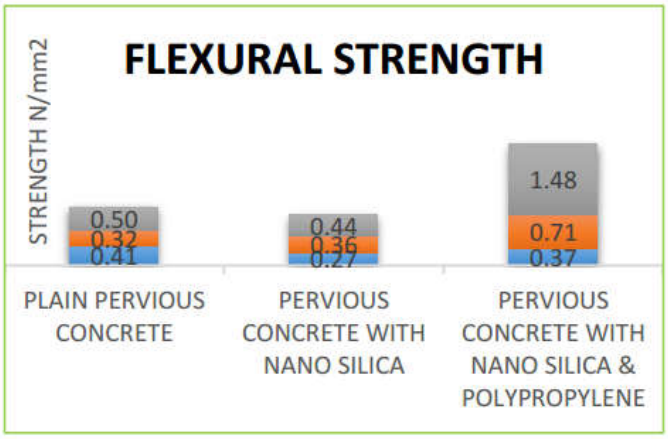
Comparative results for Compression

Comparing the results of compression from the 3 type of specimens it is typically found that the mix containing Nano silica has relatively high strength compared with that of the conventional one. It is clearly observed that even though there is a failure in the mix3 but the cubes underwent partial failure rather than complete failure.

MIX	COMPRESSION STRENGTH (N/mm^2)		
TYPE	**7 DAYS**	**14 DAYS**	**28 DAYS**
MIX 1	4.89	5.11	6.67
MIX 2	6.67	8.45	8.45
MIX 3	4.45	3.34	2.22

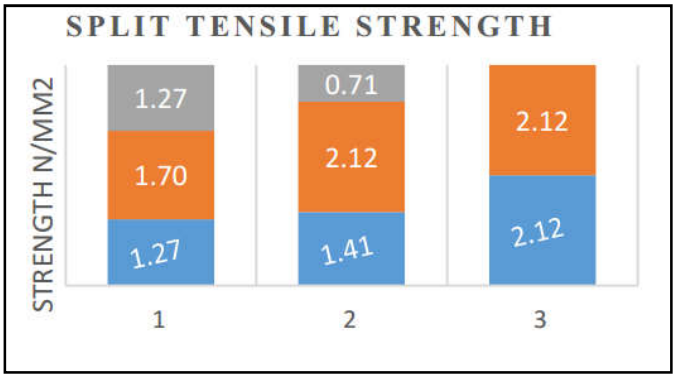
Comparative results for Split Tensile

It is clearly seen that the split tensile strength is high for the first two mixes due to the bonding between aggregates and cement. Whereas for mix 3 the split tensile strength is slightly lower than the other two. This might be due to the low bonding between polypropylene fibers and the aggregate.



Comparative results for Flexure

Comparing the results of compression from the 3 type of specimens it is typically found the mix containing Nano silica has relatively high strength compared with that of the conventional one. The 3rd mix withstands a high flexural strength than the other 2 mix.



Permeability analysis

Permeability test is an important test required for determining the permeability or draining capacity of pervious concrete, which is the core idea of the project. From the testing values it is found that the values of permeability are relatively higher for Conventional concrete, a little low for Pervious concrete with Nano Silica and even low for Pervious concrete with Nano Silica and Polypropylene.

Type of mix	Discharge (m^3/hr)
Pervious Concrete	15.43
Pervious Concrete with Nano silica	14.51
Pervious Concrete with Nano silica And Polypropylene	12.62

Failure of mix containing nano silica & polypropylene

We have gained more strength at the beginning. But gradually it became low during 14 and 28 days of testing. The loss of strength is majorly on the mix containing Nano Silica and Polypropylene. The reduction in strength is due to bonding failure between Cement and polypropylene. This can be rectified if superplasticizer is mixed with polypropylene for better bonding. The testing results clearly shows that the mix 3 containing Nano Silica and Polypropylene has failed. But the failure is only a partial failure and not a complete failure. The bonding of Polypropylene fibers in between the concrete withholds the concrete from complete segregation.

Conclusion

Pervious concrete or No fineness concrete can be used as pavement generally and the usage of admixture with conventional Nano silica increases the strength and the mix attained its maximum strength in 14 days itself. So can be used for low road bearing roads. It is also an Environment Friendly system where the ground water is recharged simultaneously. The results were as expected for the conventional pervious concrete in terms of permeability and strength characteristics. The strength is high for conventional pervious concrete and also the concrete layer is capable of draining 15.4 m3 of water over a surface area of 1m2 over a time of 1hr. The results of the mix 2 containing Pervious concrete with Nano Silica has relatively high strength and has relatively low permeability of 14.5 m3 of water over a surface area of 1m2 over a time of 1hr. The Nano silica is found to be have increased strength during 14 days' strength. As the results exhibit failure results for mix 3 containing Nano Silica and Polypropylene, due to partial bonding between polypropylene fibers and cement. The failure is also a partial failure. The mix doesn't fail completely due to

the bonding between polypropylene fibers. This failure can be rectified by using Super Plasticizer and certain research papers indicated the use of Super Plasticizer helps more bonding between fibrous material and concrete. The project is completely analyzed and it is clearly seen that Conventional pervious concrete and Pervious concrete with Nano silica holds good for strength characteristics. The Permeability is high for Pervious concrete and low for other two mix. Further studies have to be done for increasing strength using polypropylene fibers or other components.

REFERENCES

ACPT (Advanced Concrete Pavement Methodology), "PERVIOUS CONCRETE", Techbrief, FHWA-HIF-13-006, December 2012.

Behrooz Shirgir, Amir Reza Mamdoohi, Abolfazl Hassam, "*International Journal of Transportation Engineering*", Vol-2, No-4, Autumn 2014, Page No:307-316.

Dania M. Abdel-Aziz, Duaa O. Al-Maani, Wael Al-Azhari, "Using pervious concrete for managing storm water run-off in urban neighborhoods: Case of Amman", *American International Journal of Contemporary Research*, Volume 5, No:2, April 2015, Page No: 78-86.

Darshan S. Shah, Jayeshkumar Pitroda, "An Experimental study on Durability and water absorption properties of Pervious concrete", *International Journal of Research in Engineering and Technology*, Volume-03 Issue-03, March 2014, Page No: 439-444.

Darshan S. Shah, Jayeshkumar Pitroda," An experimental study on Hardened properties of Pervious Concrete", *Journal of International Academic Research for Multidisciplinary*, Volume 2, Issue-3, April 2014, Page No: 332-338.

Darshan S. Shah, Prof. Jayeshkumar Pitroda, Prof. J. J. Bhavsar, "Pervious Concrete: New Era for Rural Road Pavement", *International Journal of Engineering Trends and Technology*, Volume-4 Issue-8, August 2013, Page No:3495-3499.

Ferguson, B.K., "Porous Pavements", New York: Taylor and Francis Group, 2005, 577 pages.

Gammampila, Mendis, Ngo, Aye, Jayalath, Rupasinghe, "Application of Nano materials in the sustainable environment", *International conference on sustainable Build environment*, 13-14 December 2010, Page No:20-27.

Harshavarthana Balaji. M, M.R. Amarnaath, R.A. Kavin, S. Jaya Pradeep, "Design of Eco Friendly Pervious Concrete", International *Journal of Civil Engineering and Technology*, Vol-6 Issue 2, February 2015, Page No:22-29.

http://lib.dr.iastate.edu/rtd/?utm_source=lib.dr.iastate.edu%2Frtd%2F93&utm_medium=PDF&utm_campaign=PDFCoverPages

http://secement.org/pervious_concrete.htm

http://www.cement.org/for-concrete-books-learning/materials-applications/pervious-concrete/pervious-concrete-durability

http://www.concretenetwork.com/pervious/

http://www.pervioussrete.com/

http://www.perviouspavement.org/

https://en.wikipedia.org/wiki/Pervious_concrete

Husain N Hamdulay, Roshni J John, D.R. Suroshe, *International Journal of Innovative Research in Science, Engineering & Technology*, "Effect of Aggregate Grading and Cementitious By-Product on performance of Pervious concrete", Vol-4, Issue 8, August 2015, Page No:6890-6897.

Neetu B. Yadav, Jayesh A. Shah, Rushabh A. Shah, "Pervious concrete: Solution for Low Cost Construction", *International Journal of Innovative Science and Modern Engineering*, Volume I, Issue-10, September 2013, Page No:38-41.

Patil. V.R, Prof. A.K. Gupta, Prof. D.B. Desai, "Use of Pervious concrete in construction of Pavement for Improving their performance", *IOSR Journal of Mechanical and Civil Engineering*, ISSN:2278-1684, Page No:54-56.

Stephen A. Arhin Ph.D., P.E., PTOE, Rezene Madhi, Ph.D. Mr. Wasi Khan," Optimal mix designs for pervious concrete for an urban area", *International Journal of Engineering Research and Technology*, Volume 3, Issue 12, December 2014.

Tanvir Hossain, Md. Abdus Salam, Mohiuddin Abdul Kader, "Pervious concrete using brick chips as coarse aggregate: An experimental study", *Journal of Civil Engineering*, 2012, Page No: 125-137.

US EPA, "Storm Water Technology Fact Sheet: Porous Pavements", EPA 832-F-99-023, US Environmental Protection Agency, Office of Water, Washington D.C., 1999.

****