Permeable Concrete as a Road Pavement for a Stormwater: A Report

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Abstract— The invention discloses permeable concrete and a pavement construction method. The permeable concrete comprises the following components: 1300 to 1810 parts of broken stones, 92 to 152 parts of water, 350 to 400 parts of cement, 20 to 85 parts of mineral powder, 20 to 85 parts of silicon ash and 0.4 to 8 parts of water reducing agent; if necessary, organic intensifying agent can be added. The construction method comprises the following steps: permeable concrete is mixed, poured and cured, an expansion joint is cut, and the filling and the other processes are performed. Concrete pavement prepared by the method has higher strength and water permeability, and the compression strength can reach or exceed 35 MPa; the flexural strength is above 5 MPa; the coefficient of water permeability is more than or equal to 2 mm/s; the requirements for the permeable concrete pavement can be fully satisfied. The permeable concrete is suitable for the construction of permeable concrete pavement, squares and parking lots; by adopting the method, the consumption of cement is small, the construction is simple, and the method is favourable for being popularized.

Key words: Permeable, Concrete, Pavement, Stormwater

I. INTRODUCTION

India is a developing country and safety of roads is still in a Pervious concrete pavement rad is a unique and effective means to address important environmental issues and support green, sustainable growth. By capturing storm water and allowing it to seep into the ground, porous concrete is instrumental in recharging groundwater table, reducing stormwater runoff in surface.

In concrete amounts of water and cement materials are used to make a paste that forms a thick coating around aggregate small particles. Using sufficient paste to coat and bind the aggregate particles together make a system of highly permeable, interconnected voids that drain quickly. Typically, between 22% and 34% voids are achieved in the hardened concrete

Permeable concrete pavements are used mostly in rural area. A pervious concrete mixture contains little or no sand, creating a substantial void content. This concept of pervious concrete is relatively new for rural road pavement.

This dissertation analyses the effectiveness of Permeable concrete in Road. This was achieved by analysing the characteristics and properties of Permeable concrete. The performance of Permeable concrete was compared with a concrete sample that is comparable to the material used for the construction of conventional concrete road pavements.

The tests conducted to determine the fresh concrete properties were the compacting factor tests and slump test. These were complimented by hardened concrete tests including the following: indirect tensile strength, compressive strength. After that there is a comparisons are made between the both type of concrete.

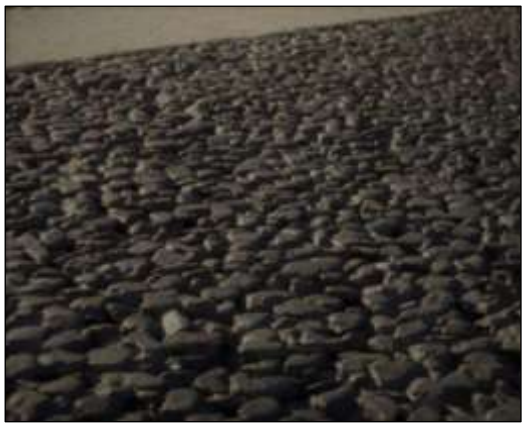

Fig. 1: Permeable concrete road pavement

It was found that Permeable concrete pavements possess some positive features like increased skid resistance and high permeability but lacks the high strength required for highly traffic areas. Permeable concrete has proven to have properties suitable for use in low volume traffic areas. The properties found may change depending on the aggregate particle chosen, however this aspect requires further investigation. Nonetheless, if Permeable concrete pavements can be implemented, it will have numerous positive effects on the environment.

II. LITERATURE REVIEW

Malhotra (1976), found that the density of permeable concrete is generally about 70 percent of conventional concrete when made with similar constituents. The density of permeable concrete using conventional aggregates varies from 1602 to 1922 kg/m3.

Malhotra stresses that in situations where normal conditions are not achieved during placement and curing, the formwork should not be removed after 24 hours as with conventional concrete. Permeable concrete has very low cohesiveness and formwork should remain until the cement paste has hardened sufficiently to hold the aggregate particles together. However, this is more of a consideration in low temperature conditions and when used in non-pavement applications where the concrete is not sufficiently supported by the ground or other means.

Abadjieva et al (1998), determined that the compressive strength of permeable concrete increases with age at a similar rate to conventional concrete. The permeable concrete specimens tested had aggregate-cement ratios varying from 6:1 to 10:1. The 21 day compressive strength obtained by these mixes ranged from 1.1 and 8.2 MPa, with the aggregatecement ratio of 6:1 being the strongest. He concluded the most plausible explanation for the reduced strength was caused by the increased porosity of the concrete samples. This strength is sufficient for structural load bearing walls and associate applications.

Ghafoori et al produced permeable concrete with a compressive strength in excess of 22 MPa when using an aggregate-cement ratio of 4:1.

III. OBJECTIVES OF THE PROPOSED WORK

The objectives of the work would be:

1) To determine the durability, properties of permeable concrete.
2) To determine the impact resistant of permeable concrete pavement.
3) To compare the properties of permeable concrete with the existing concrete pavement.

IV. MIX DESIGN

The mix design in this case was the determination of the ratio of aggregate, cement and water that possessed the most favorable properties. For this particular situation trial mixes were designed. The mixes were determined from previous literature and particular mixes used by some companies. There are only three constituents of Permeable concrete that can be considered and varied: aggregate, cement and water content.

A. Conventional Concrete

There was no mix design undertaken for conventional concrete, since the strength of certain mixes is readily known. This meant that no trials were required to be carried out. When conducting the tests to determine the properties of a conventional concrete.

B. Permeable Concrete

The mix designs for Permeable concrete were obtained from printed articles. There were a large number of different mixes that are currently being used for a whole range of applications.

Aggregate	Cement	Water
8	1	0.4
6	1	0.4
4.5	1	0.4
4.8	1	0.36

Table 1: Mix Proportions Used For Permeable Trial Mixes

C. Trial mix Result and Analysis

Half the specimens were tested for compressive strength and indirect tensile strength at 14 days. The remaining small and large specimens were tested for 21-day compressive strength. The results of those tests can be found in the table below.

	14 Day Strength		28 Day Strength	
Aggregate-Cement-Water ratio	Compressive Strength (MPa)	Indirect Tensile Strength (MPa)	Compressive Strength (MPa)	Compressive strength of large cylinders (MPa)
8:1:0.4	4.23	1.05	3.06	5.97
	4.23		3.72	
6:1:0.4	5.60	1.62	7.41	5.44
	8.02		7.62	
4.5:1:0.4	7.64	2.25	11.18	7.60
	7.78		12.85	
4.8:1:0.36	7.78	1.05	6.35	5.22
	7.32		6.25	

Table 2: The Data Collected From the Trial Mixes

From the 14-day testing, the aggregate-cement-water ratio of 3.5:1:0.4 was chosen as the most suitable mix since it produced the highest average compressive strength and possessed the greatest indirect tensile strength. The rest of the analysis will be completed using this mix design

V. RESULTS AND ANALYSIS

A. Compacting Factor Test

Types	Partially compacted (m1) kilograms	Fully compacted (m2) kilograms	Compacting Factor
No-Fine concrete	10.815	11.332	0.90
Conventional concrete	13.035	13.440	0.96

Table 3: Shows the Compacting Factor for All Thesamples of Concrete Used

B. Compressive Strength Test

Test No.	Specimen No.	Force P(KN)	Cross Sectional Area (mm^2)	Compressive Strength (Mpa)	Average Compressive Strength (Mpa)
1	Permeable	116.3	7854	14.8	
2	Permeable	164.5	7854	20.9	
3	Permeable	141	7854	17.95	17.045
4	Permeable	114.7	7854	14.60	
5	Permeable	123.8	7854	15.76	
6	Permeable	143.4	7854	18.26	
7	Conventional	318	7854	40.5	
8	Conventional	300	7854	38.2	39.8
9	Conventional	311	7854	39.6	
10	Conventional	318	7854	40.5	

Table 4: Shows the Force Determined From the Testing Machine and the Cylinder Compressive Strength of the Test Specimen

VI. CONCLUSION

There was a considerable difference in the compressive strength between the concrete samples but this does not affect the outcome as it was the relationships between the characteristics that were assessed. The relationships showed that Permeable concrete acts in a manner similar to what was found in the conventional concrete sample.

A major difference found was that the Permeable concrete deformed more than the conventional sample before failure. This shows that a Permeable pavement has the ability to deform under the loading of traffic. The deformation should not affect the performance of the pavement providing its capacity is not exceeded.

VII. FUTURE SCOPE

We can use 25 mm aggregate size for future study or analysis. Pervious concrete is a special type of concrete with a high porosity used for concrete pavement applications that allows water from precipitation and other sources to pass directly through it, thereby reducing the runoff from a site and allowing groundwater recharge.

REFERENCES

[1] Storm Water management using remote sensing and GIS - a case study of Surat city (India) Authors: Ajay Gamit,P.P. Lodha,Indra Prakash and Khalid Mehmood, Journal JETIR1705037
[2] Malhotra, V. M. 1976. "Permeable Concrete – Its Properties and Applications", Journal of the American Concrete Institute. Vol 73. No. 11. pp 628 – 644
[3] Sharma Devinder, Sharma Sanjay, Goyal Ajay, 2016, Utilization of Waste Foundry Slag and Alccofine in Developing High Strength Concrete, International Journal of Electrochemical Science, 11 (2016).
[4] Ayers, R 2004. "Transport Engineering – Study book. University of Southern Queensland".

