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Characteristic behaviour of porous concrete and conventional concrete

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ABSTRACT

Porous concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. Porous concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways, and greenhouses. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to In the presence of clayey soil, water can be percolated through providing borehole at every 1-2km with the help of drainage system.

Water can be filtered and stored as the freshwater below the ground.

We can also give direction to water specifically according to need. By providing the certain angle to the flaky aggregate water which gets drained will make its way to the slope going down towards the sewer line or any other drainage arrangement. This could be useful where soil strata have less water absorption capacity.

Keywords: *Compressive Strength, Porous Concrete, Conventional Concrete.*

1. INTRODUCTION

Porous concrete (also called porous concrete, Porous concrete, no fines concrete and porous pavement) is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a.

Porous concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. Porous concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways, and greenhouses. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to protect water quality

Porous concrete is a mixture of cement, water, and a particular sized coarse aggregate combined to form a Porous structural material. It has a high volume of voids, which is the factor responsible for the lower strength and its light weight nature. Porous concrete is also called Porous concrete, zero-fines concrete, and Porous concrete.

- Highly porous allows rapid surface water removal
- Reduces risk of flooding
- Reduces freeze/thaw attack
- Reduces the requirement for more expensive drainage systems
- Reduces maintenance costs for storm water management

Pervious concrete has a void content range from 15% to 35% of total volume of concrete which gives higher permeability as the purpose of this concrete. But another hand, higher porosity decrease the amount of compressive strength of pervious concrete than conventional concrete.

Use of fine sand at limit from 5% to 10% can give enough structural strength in pervious concrete. But further increment of sand can control the strength properties of pervious concrete

The compressive strength of conventional pervious is lower than 15 to 20 MPa [4]. But with use of modifications in coarse aggregates can increase strength in the range of 12 to 14% than conventional compressive strength

Porous concrete is mostly used in non-pavements applications, limited use in pavements applications. This assignment purpose is to assess the suitability for Porous concrete to be used for the construction of road pavements.

This will include investigation of current literature on the topic and conduct standard concrete testing on Porous concrete and conventional concrete to determine and evaluate their properties. With the help of tested data, a conclusion is made on the usefulness of Porous concrete pavements and it may be determined that further testing is required.

2. LITERATURE REVIEW

Klemas, 2015)The population in urban areas can grow so fast that storm water drainage systems are not installed or the increase of impervious surfaces overwhelm the storm water sewage system that is
in place

Krishna Raju et al (1975) focused on the optimum water content for Porous concrete. It was determined that for the particular aggregate-cement ratio there is a narrow range for the optimum water-cement ratio. This water-cement ratio was imperative to gain the maximum possible compressive strength. A higher than ideal water-cement ratio would cause the cement paste to drain from the aggregate particles. Alternatively, a water-cement ratio too low would stop the cement paste from adhering sufficiently to the aggregate. When the optimum water-cement ratio was not obtained, sufficient compaction could not be achieved, further compounding the loss of compressive strength.

Abadjieva et al (1997) investigated the influence of the aggregate-cement ratio on the tensile and flexural strength of Porous concrete. This study only assessed aggregate-cement ratios ranging from 6:1 to 10:1. The highest strengths were obtained with an aggregate-cement ratio of 7:1 and the strength decreased with an increasing aggregate-cement ratio. He found that the tensile and flexural strengths of Porous concrete were considerably lower than those obtained from conventional concrete, but he could not explain why the sample with the highest strength had a ratio of 7:1.

Baoshan Huang(2009)[4] carried out the experiment on pervious concrete with use of latex polymer to improve the strength properties. With the use of latex, natural sand and fiber they evaluated the effect of polymer modification on mechanical and physical properties of PMPC. Based on results, it was possible to produce a pervious concrete mixture with acceptable permeability

Objectives of the Proposed work

1) Find out durability, properties of Porous concrete.

2) To conclude impact resistant of Porous concrete asphalt road.

3) To compare the properties of Porous concrete with the existing concrete roadway.

4) To find the Strength of Porous concrete.

3. EXPERIMENTAL WORK

3.1 Test Methodology

This project is focused predominantly on the use of Porous concrete as a road pavement material. As this is a comparison between Porous concrete pavements and conventional concrete pavements, there is a requirement that the tests being conducted can occur in both samples.

The test procedure included the initial steps of deciding on the tests to be conducted and choosing a number of aggregate-cement ratios for the Porous concrete. This was followed by conducting the preliminary mix design and compressive strength tests on these samples to determine the mix that performed most successfully.

3.2 Concrete Tests

The tests that were conducted had to provide a complete picture of all the characteristics of the concrete in both the wet and hardened state.

For this reason, it was proposed that the testing incorporate aggregate testing to determine the potential effect of the aggregate shape on the performance of the Porous concrete. This was followed by conducting workability tests like the slump and compacting factor tests on the wet concrete sample.

The hardened concrete tests proposed for the project were compressive strength and indirect tensile tests. This testing includes determining the void ratio and assessing the permeability of the Porous concrete.

3.3 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 Porous concrete that can be considered and varied: aggregate, cement and water content.

3.4 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.

3.5 Porous Concrete

The mix designs for Porous 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.

Table 3.1 – Mix Proportions used for Porous Trial Mixes

Aggregate	Cement	Water
7	1	0.3
5	1	0.3
4.2	1	0.3
4.6	1	0.23

3.6 Mixing Process

Figure 3.1 – Mixing of no fine concrete

3.7 Result and Analysis

Half the samples were tested for compressive strength and indirect tensile strength at 14 days. The remaining small and large samples were tested for 28-day compressive strength. The results of those tests can be found in the table below.

Table 3.2 – The data collected from the trial mixes

	14 Day Strength		**28 Day Strength**	
Aggregate-Cement-Water ratio	**Compressive Strength (MPa)**	**Indirect Tensile Strength(MPa)**	**Compressive Strength (MPa)**	**The compressive strength of large cylinders (MPa)**
8:1:0.2	4.29	1.54	3.25	6.67
	4.29		3.61	
6:1:0.3	6.68	1.62	7.54	5.33
	7.22		7.34	
4.5:1:0.3	7.34	2.29	11.72	7.62
	7.78		12.88	
4.8:1:0.26	8.81	1.53	6.41	5.25
	8.41		6.38	

3.8 Summary

The Porous concrete mix design found that an aggregate-cement-water mix of 4.5:1:0.3 produced the highest compressive strength out of the different mix proportions trialed. Since the highest compressive strength was found in the 4.5:1:0.3 mix, it was used for the remainder of the testing in this project.

3.9 Sieve Analysis

Sieve analysis is a method of determining the grading of a particular aggregate or a mixture of aggregates. The sieve analysis is carried out in a mechanical sieving machine to provide a more consistent result and achieve much greater accuracy. The sieves used vary in size but consecutive sieves used are smaller in aperture as you move down the stack. There are three different methods for undertaking a sieve analysis. Two wet analysis methods can be used, one with alcohol and the other with water.

The third method is dry analysis, which can only be used for granular particles larger than 125 m.

3.10 Compressive Strength

- The compressive strength tests are conducted to ensure a minimum strength is achieved by the particular mix. Cylinder and cube testing are methods of determining the compressive strength. Both methods of determining compressive strength will be used as it may be difficult to achieve a good result when using the cylinders.

3.11 Indirect Tensile Test

The tensile strength of concrete cannot be measured directly. This leads to the need to determine the tensile strength through indirect methods. The indirect tensile test is also referred to as the 'Brazil' or splitting test, where a cylinder is placed on its side and broken in the compression machine. This test can also be used to determine the modulus of elasticity of the concrete sample.

4. RESULTS AND ANALYSIS

4.1 Compacting Factor Test Result

Table 4.1 – Shows the Compacting Factor for all the samples of concrete used

Types	Partially compacted (m1) kilograms	Fully compacted (m2) kilograms	Compacting Factor
No-Fine concrete	10.726	11.413	0.95
Conventional concrete	13.041	13.462	0.97

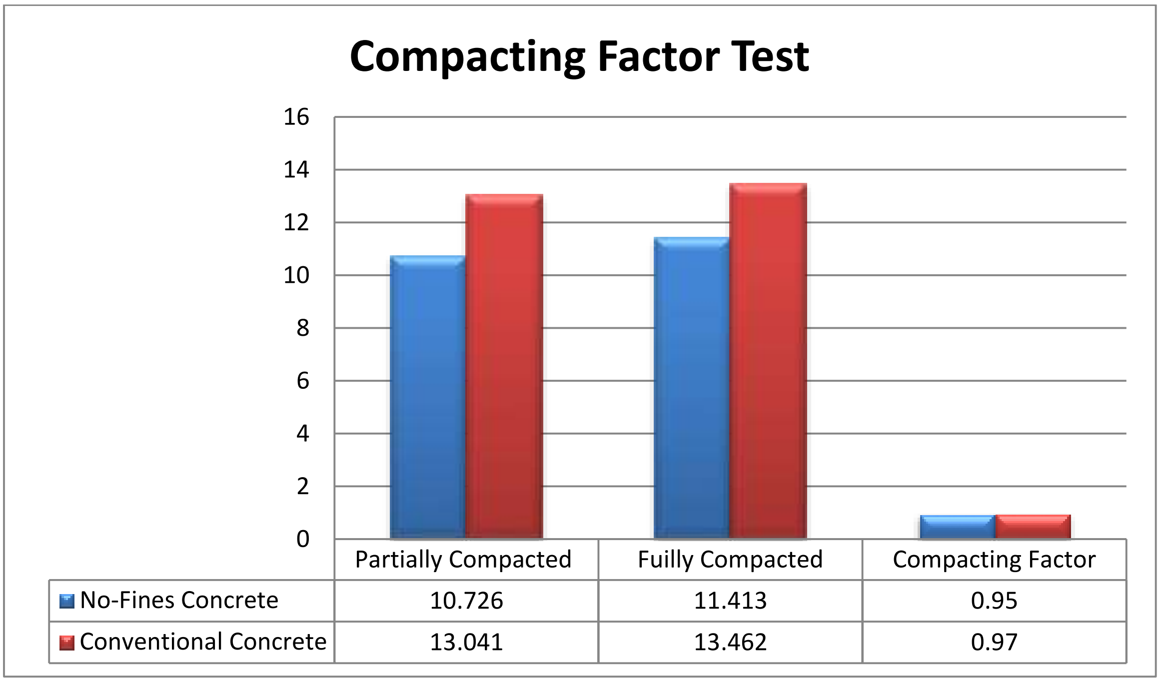

Figure 4.1 - Chart of compacting Factor for all the samples of concrete used

Porous concrete is a self-compacting material and this test determines its ability to compact itself dropping from a set height. Porous concrete can be dropped from large heights and this test shows these properties by the amount of compaction obtained from simply allowing the concrete to drop.

4.2 Compressive Strength Test Result

Table 4.2 –Force determined from the testing machine and the cylinder compressive strength of the test sample

Test No.	Sample No.	Force P(KN)	Cross Sectional Area(mm^2)	Compressive Strength (Mpa)	Average Compressive Strength (Mpa)
1	Porous	121.3	7851	11.7	
2	Porous	159.5	7851	18.9	
3	Porous	140	7851	15.95	**15.045**
4	Porous	100.7	7851	13.60	
5	Porous	119.8	7851	14.76	
6	Porous	140.4	7851	16.26	
7	Conventional	314	7851	37.5	
8	Conventional	296	7851	36.2	**37.8**
9	Conventional	308	7851	37.6	
10	Conventional	314	7851	39.5	

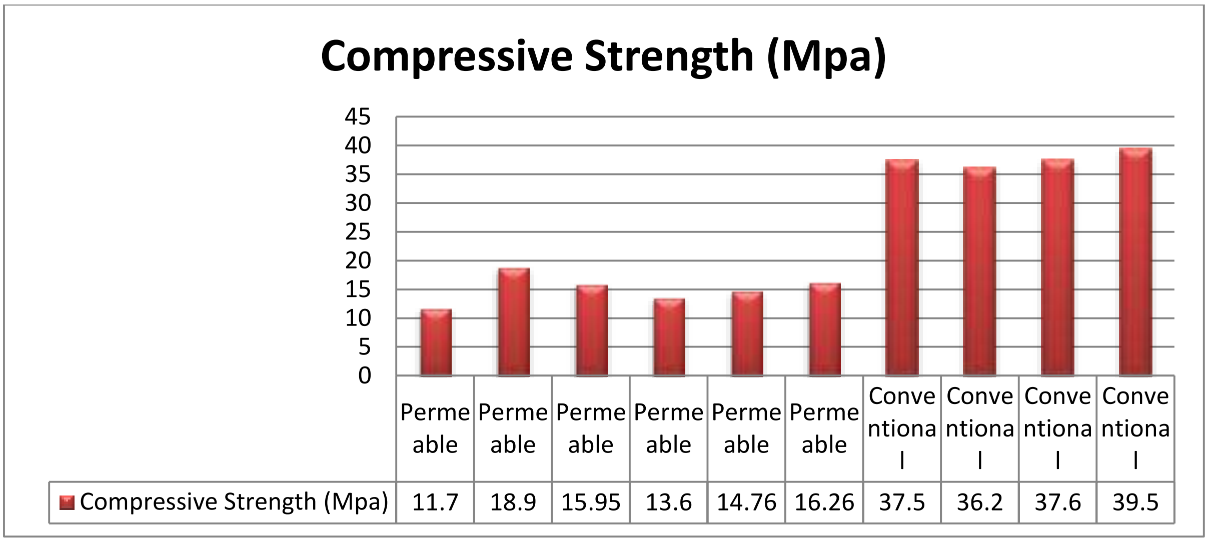

Figure 4.2 Comparison of the chart of force determined by the testing machine and the cylinder compressive strength of the test sample

4.3 Indirect Tensile Strength Test Result

Table 4.3 – Shows the results of the indirect tensile test

Test No.	Sample No.	Force P(KN)	Length L(mm)	Diameter(mm)	Indirect Tensile Test(Mpa)	Average Indirect Tensile Test(Mpa)
1	Porous	114	300	150	1.44	
2	Porous	149	300	150	2.22	
3	Porous	186	300	150	2.63	2.88
4	Porous	109	300	150	1.47	
5	Porous	179	300	150	2.42	
6	Porous	188	300	150	2.49	
7	Conventional	252	300	150	3.43	
8	Conventional	223	300	150	3.27	3.59
9	Conventional	230	300	150	3.45	
10	Conventional	246	300	150	3.48	

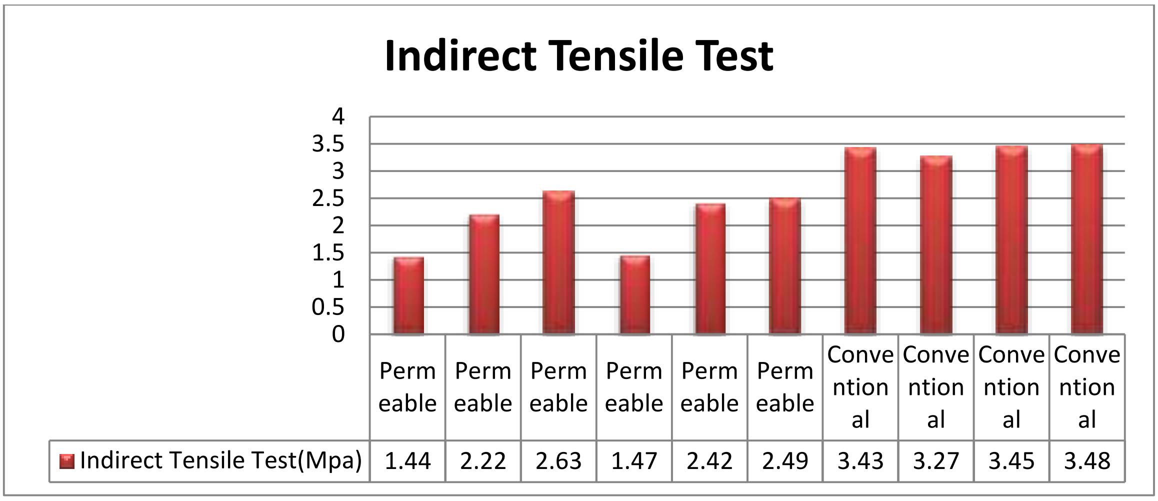

Figure 4.3 - Shows the results of the indirect tensile test

5. CONCLUSION

There was a considerable difference in the compressive strength of 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 Porous concrete acts in a manner similar to what was found in the conventional concrete sample.

A major difference found was that the Porous concrete deformed more than the conventional sample before failure. This shows that a Porous 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.

Porous concrete is a viable material that has the potential to replace the use of traditional concrete pavements in situations where heavy traffic is limited, such as car parks, residential streets, and driveways. More widespread applications may be possible if methods of reducing the raveling that occurs within the top aggregate are found.

The varying compressive strengths obtained from the different aggregate samples shows that the shape of the aggregate particles used can dramatically affect the strength of the concrete.

6. FUTURE SCOPE

We can use 24 mm aggregate size for future study or analysis. Pervious concrete is a special type of concrete with a high porosity used for concrete roadway applications that allows water from rainfall and other sources to pass directly through it, thereby reducing the runoff from a site and allowing groundwater boost.

- A major difference found was that the Porous concrete deformed more than the conventional sample before failure. This shows that a Porous 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
- Porous concrete can be used in building for rainwater harvesting as well as for cooling purpose by providing Porous wall.

- In the presence of clayey soil, water can be percolated through providing borehole at every 1-2km with the help of drainage system
- Water can be filtered and stored as the fresh water below the ground.

7. REFERENCES

[1] Ghafoori et al (1995) produced Porous concrete with a compressive strength in excess of 20 MPa when using an aggregate-cement ratio of 4:1.
[2] Australia Standard, As 1012.2 – 1994. "Method 2: Preparation of concrete mixes in the laboratory", Standard Australia Committee. Australia standard, AS 1012.3.1 – 1998. "Method 3.1;7: Determination of properties related to the consistency of concrete – Slump Test", Standard Australia Committee.
[3] Jump up^ Kevern, J.T., and Farney, C. "Reducing Curing Requirements for Porous Concrete Using a Superabsorbent Polymer for Internal Curing." Transportation Research Record: Journal of the Transportation Research Board (TRB), Construction 2012, Transportation Research Board of the National Academies, Washington D.C.
[4] Australian Standard. AS 1012.3.1 – 1998. Method 3.1: "Determination of Properties related to the Consistency of Concrete" – Slump Test. Standards Australia Committee.
[5] Ayers, R 2004. "Transport Engineering – Study book. The University of Southern Queensland".
[6] Department of Civil Engineering University of Botswana.
[7] D'Arcy BJ, Usman F, Griffiths D, Chatfield P. Initiatives to tackle diffuse pollution in the UK. Water Science and Technology 1998; 38(10): pp.131–8, 2006.
[8] Tota-Maharaj, K., Grabowiecki, P., and Scholz, M., Energy and temperature performance analysis of geothermal (ground source) heat pumps integrated with permeable pavement systems for urban run-off reuse International Journal of Sustainable Engineering, Vol. 2 (3), pp.201–213, 2009
[9] Grabowiecki, P., Scholz, M. and Coupe S.J. Combined permeable pavement and ground source heat pump
[10] Basavararajaiah, B. S. & Krishna Raju, N. 1975. "Experimental Investigations on Porous Concrete", Journal of the Institution of Engineers India. Part CV: Civil Engineering Division. Vol 55. No. Pt. CI 4. March. pp 137-140.

