PERFORMANCE OF POROUS CONCRETE BLOCK FOR IMPERVIOUS PAVEMENT

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ABSTRACT

Nowadays, the application of concrete block pavement in road construction industry is increasing rapidly. This is because the concrete block pavement (CBP) can produce a variety of beautiful patterns pavement surface and it becomes a choice on how to further views of cities. However, water on the pavement surface often occurs and it can affect the quality of the pavement. To overcome this problem, the system of concrete block permeable pavement (CBPP) has been widely used in a number of developed countries. In CBPP system, the water will be allowed to seep into the bedding layers and sub-base through the gap between the concrete blocks filled with coarse sand filler. Space for water seepage through the blocks is limited if clogging material accumulated in the filler sand and it can lead to slow diffusion rate. Studies have been done to modify the concrete blocks that are common to the porous concrete blocks to accelerate the loss of water on the surface of the pavement. Based on past research, porous concrete has disadvantages in terms of strength and durability, the glass fibers used in the porous concrete mix to overcome the weakness. Concrete compressive strength test and water seepage tests were performed on concrete blocks that have been modified for comparison in terms of strength and infiltration rate of the concrete block. From the results, it was found compressive strength of porous concrete block is very low compared to the control concrete block strength with reduction of 75.29%. Even, the addition of glass fibers in the mixture cannot help to improve the compressive strength of porous concrete block. The rate of water seepage in a block of concrete is about 241cm3 / s for filler-filled pores. While, the rate of water seepage to the model pavement 60cm x 120cm stood at 2938 cm3 / s for pores and gap fill with filler.

Keywords: concrete block pavement, concrete block permeable pavement, fibers

1. Introduction

Concrete block pavement (CBP) is generally used in the street, bus terminals, bus stops, parking and recreational gardens. This is due to the characteristics of the concrete block pavement itself has a high aesthetic value. Some of existing aesthetic value at CBP is the diversity of shapes, colors, sizes and patterns of order.

Other than the physical advantages, CBP has an advantage in terms of construction. This is because CBP does not require heavy machinery. Furthermore, it can be opened to traffic immediately after completion of construction and concrete blocks can be recycled. This can reduce the cost of pavement maintenance and is more environmentally friendly.
Although CBP is now received a good response and has been used in many places, but the research on this field is still in its infancy. Further study should be done before it can be fully accepted.

1.1. Problem statement

Water is the main factor to the failure of the pavement. If water seeps into the subgrade layer in large quantities, it cause deposition occurred on the pavement. Besides, if the flow of water on the pavement surface is not smooth, it will cause discomfort to the user and can cause accidents. To overcome this problem, CBPP system was used, the water will be allowed to seep into the bedding layer and sub-base through the gap between the concrete blocks filled with coarse sand filler. Space for water absorption is limited if the pores in the sand filler accumulated clogging material can slow the seepage rate. Porous concrete blocks aimed to increase space for water absorption through the block. Some of the tests that have been done are the water seepage rate test. Porous concrete blocks would help in enhancing the seepage rate of water through the block. However the pores on the block have not escaped infiltrated by filler material and fine dust. In addition, porous concrete has disadvantages in terms of strength, so these constraints has been selected as the problem statement and take account during the study.

1.2. Objective

The objective of this study is:

i. To study the compressive strength of porous concrete blocks than ordinary concrete blocks.
ii. To study the effects of different aggregate nominal size and the addition of glass fibers in a porous concrete block against compressive strength.
iii. To determine the rate of water seepage through the porous concrete block and porous concrete block pavement.

1.3. Scope of study

This study used a concrete block size (200 × 100 × 80) mm and confined to a concrete block and does not take into account the impact against the subgrade layer. Aggregate nominal sizes that are used in the design of porous concrete are 10mm and 14mm and the use of glass fiber as an additive with a percentage of 0.1% and 0.3%. The study is limited to laboratory testing and any case studies were not conducted.

2. Method

2.1 Sieve analysis test

Procedure and method for sieve analysis is based on BS1377: Part 2:1990 which is sieve analysis intended to separate the aggregate according to their size. Sieve size that will be used are as 20.0mm, 14.0mm, 10.0mm, 5.0mm, 3.35mm, 1.18mm, 0.425mm, 0.150mm, 0.075mm and pan.

2.2. Cube compressive strength test

Cube compressive strength test is kind of destroyed experiments where the sample will be destroyed after the test. This test is used to test the compressive strength of concrete blocks according to the experimental day. In this study, the compressive strength of concrete blocks will be tested on day 7, 14 and 28 to obtain the strength of concrete at the age of maturity. Concrete cube samples that will be tested are concrete cube control, porous concrete cube with aggregate nominal sizes 10 mm and 14 mm, and porous concrete cubes with a mixture of glass fibers of 0.1% and 0.3%.

2.3. Seepage rate test

This experiment was designed to obtain the rate of water seepage in porous concrete block and porous concrete block pavement model. Seepage rates were tested using 500ml cylinder for porous concrete blocks and aquarium with size 42cm x 22cm x 23cm to porous concrete block pavement model. Cylinders and the glass panels will be filled with water and allowed to seep into the concrete block. Time to water will seep was recorded.

3. Results

Based on the research conducted, the results and the data were obtained. Analysis and related research conclusions will be made based on these data as well as to achieve the objectives and goals of the planned study.

3.1 Sieve analysis test

Grading sieve size against percent pass graph are made to compared with the size limits as specified distribution. Thus, there are two sieves test for sand which is for produce concrete blocks and bedding sand for the pavement. Meanwhile coarse aggregate sieve test performed to produce concrete blocks. Based on Figure 3.1 until Figure 3.3, all types of aggregate used are within the limits prescribed.

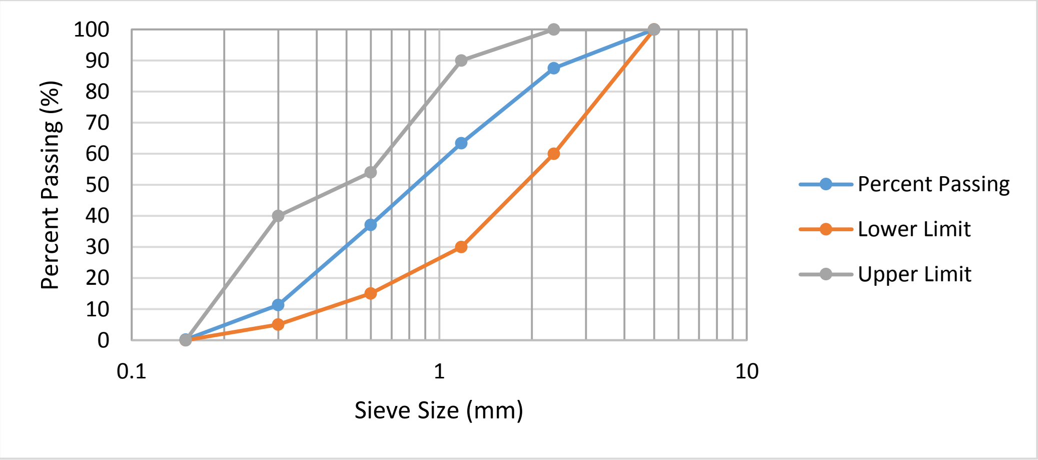

Figure 3.1. Sand graph curve

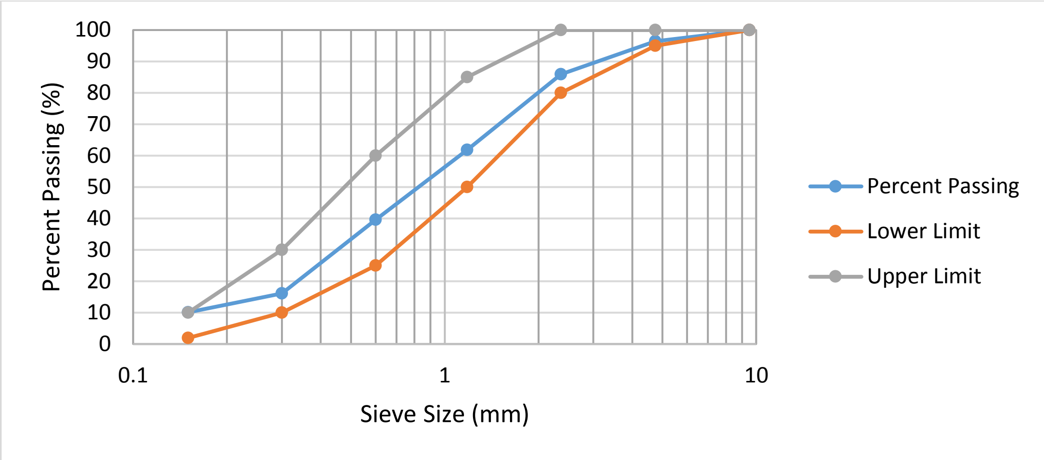

Figure 3.2. Bedding Sand graph curve

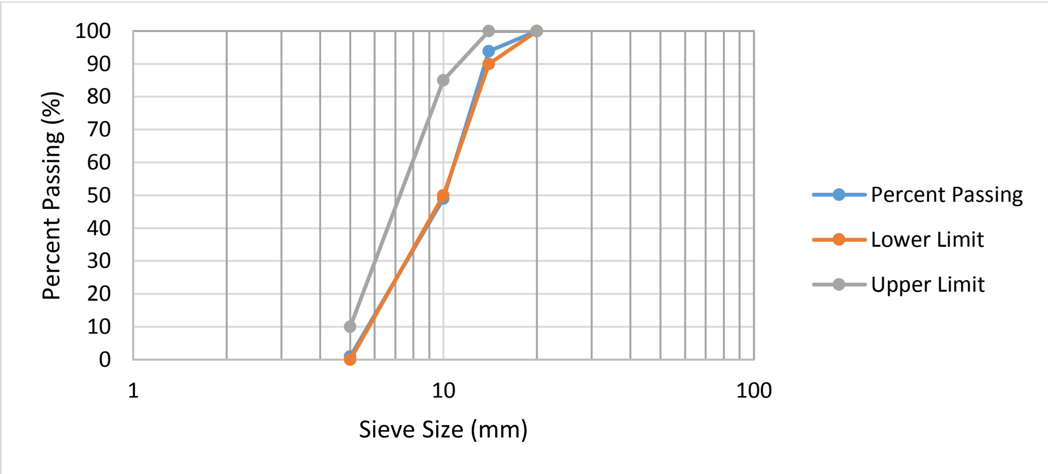

Figure 3.3. Coarse aggregate graph curve

3.2. Cube compressive strength test

Based on Figure 3.4, the differences between nominal sizes of aggregate on porous concrete blocks do not give significantly different strengths. However, porous concrete blocks have a very significant difference in the strength of the control concrete with strength difference of 75.29%. Based on Figure 3.5, the compressive strength of porous concrete blocks with the addition of glass fibers cannot compete with the compressive strength of porous concrete blocks without the addition of fiber. In fact, the more the addition of glass fibers will cause a reduction in the compressive strength of porous concrete.

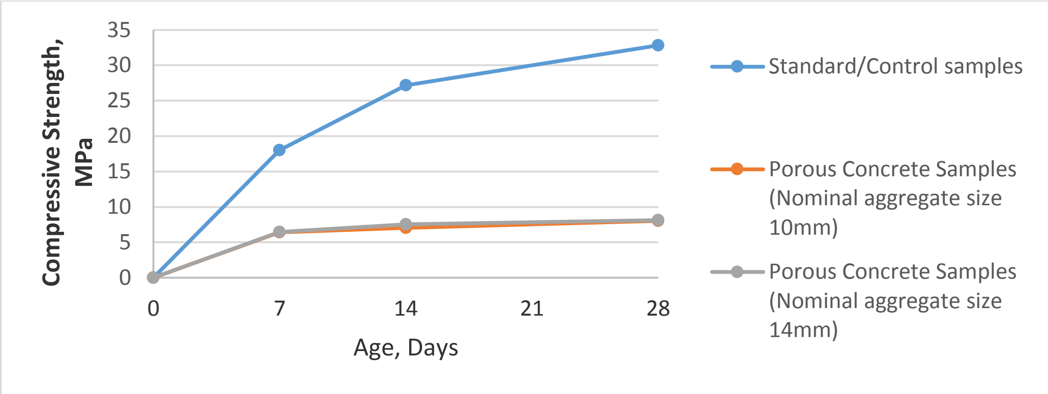

Figure 3.4. Relations between Concrete Compressive Strength with Age

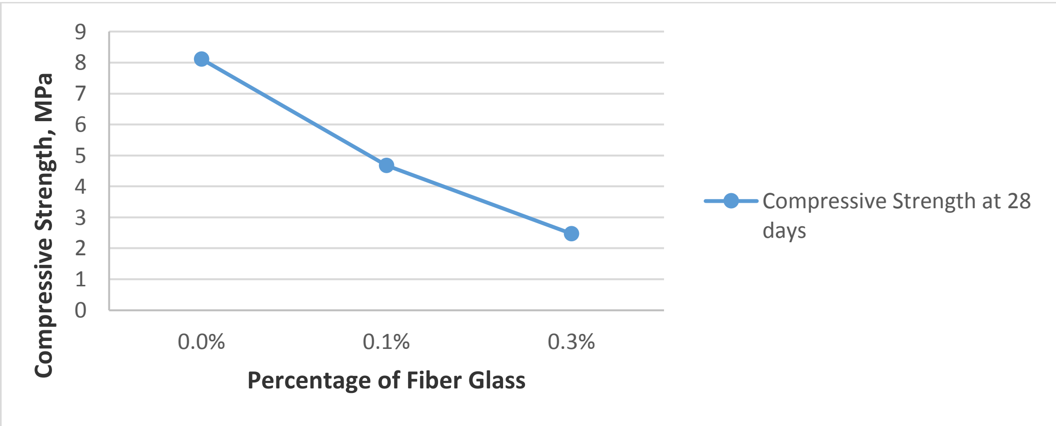

Figure 3.5. Relations between Compressive Strength with The percentage of glass fiber

3.3. Seepage rate test

Table 3.1 shows the result obtained from seepage test for porous concrete block. Based on the results obtained, the rate of water seepage through the porous concrete block was 3010 cm^3 / s. For pores on the block filled with half full sand filler stood at 297 cm^3 / s. whereas, for pores completely filled with sand filler was recorded at 241 cm^3 / s. Figure 3.6 shows a graph of depth versus time for water seepage experiments for porous concrete block pavement. Water seepage rate for pavement model size 60cm x 120cm is 2938 cm^3 / s.

Table 3.1. (a) pores and gab are not filled with filler; (b) pores and gab are filled half full with filler; (c) pores and gab are filled full with filler

(a)

Readings	Time (s)	Readings	Time (s)
1	47.97	7	47.84
2	41.47	8	49.55
3	71.50	9	74.21
4	57.35	10	42.39
5	59.24	11	58.79
6	48.46	12	60.15
		Average	54.91

(b)

Readings	Time (s)	Readings	Time (s)
1	4.84	7	4.68
2	4.63	8	4.69
3	9.57	9	9.59
4	5.43	10	3.22
5	4.72	11	4.90
6	3.68	12	5.00
		Average	5.41

(c)

Readings	Time (s)	Readings	Time (s)
1	58.19	7	55.56
2	68.37	8	61.87
3	80.23	9	78.80
4	67.21	10	61.13
5	72.25	11	72.57
6	65.76	12	69.23
		Average	67.60

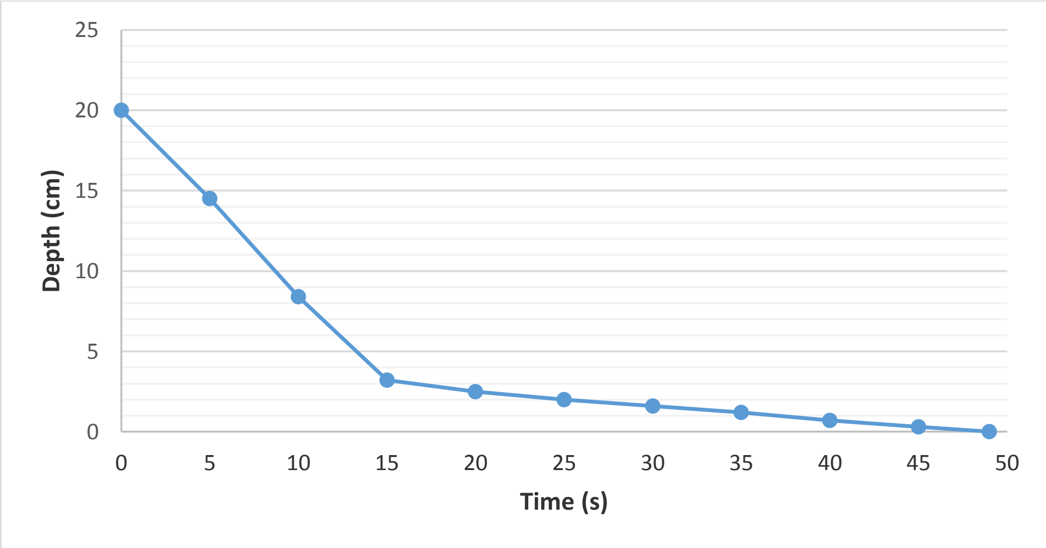

Figure 3.6. Depth (h) versus time (s) Graph

4. Discussion

After conduct a study and do the data analysis, the findings show that the differences of aggregate size distribution in this study does not provide a significant difference in terms of compressive strength. The addition of glass fibers in the mixture of porous concrete blocks cannot afford for increase the compressive strength of the concrete block. In fact, the higher value of the glass fiber content the lower the compressive strength of porous concrete block. The rate of seepage of water through a porous concrete block is very high if the pores in the concrete block are not filled with any filler material. Water seepage rate will be significantly reduced if the materials meet the increasing pores filler. The rate of seepage of water through a porous concrete block pavement will be slowed down when the sand filler and bedding sand has become fully saturated.

5. Conclusion

The addition of glass fibers in the mixture of porous concrete blocks cannot afford for increase the compressive strength of the concrete block. Water seepage rate will be significantly reduced if the materials meet the increasing pores filler. The differences of aggregate size distribution in this study does not provide a significant difference in terms of compressive strength.

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