THE COMPARING OF LABORATORY AND FIELD PERMEABILITY OF MODIFIED POROUS ASPHALT PAVEMENT

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ABSTRACT

The two types of permeability test, the first one on the lab. Indicated by Marshall Specimen and the second in the field indicated by frame steel box with dimension 150 mm length, 100 mm wide and 10 mm thickness for four types of asphalt. Generally, the experimental results indicate that adding fibers as a modifiers leads to minor modifications on strength properties of the specimens, while contributing in an important reduction in the permeability of samples. Sample were prepared of porous asphalt with two types of test are 5.5% pour asphalt cement. However each type of additives used five percent as (2, 4, 6, 8 and 10) % from the weight of asphalt cement ratio. These concentrations of polymers have been selected according to literature review and the identical concentration for each type of polymer was chosen in order to clarify the effect of polymers on reflective cracking resistance of porous asphalt pavement, when the optimum of polymer is used mixes with 6% PPV, 8% SBS and 6% LDPE, the permeability and air void are decreased not as large as that without polymer modifier by (17, 15 and 5) (6, 2 and 1) %, respectively from control asphalt cement value.

Keywords: Porous Asphalt, Permeability, Air void.


http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=9&IType=6
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1. INTRODUCTION
The ratio of fluid that flow through a porous materials under a unit head is known as the Permeability, and in the pavement medium called the hydraulic conductivity of the pavement which is depending on Darcy’s law. Kovacs further defined the method to include the properties of the transported fluid (Harris et al., 2007 and K. N. Kadhim et al., 2016).

To calculate the permeability of materials in field and laboratory tests, the Darcy’s law is usually used; in the field tests this becomes a problem because of the falling head methodology of Darcy’s law is based on the assumption of one dimensional flow. In the field test there are no effective for side boundaries that allowing to two dimensional (vertical and horizontal) flows (Cooley Jr 1999), (NAPA 2008).

2. LABORATORY PERMEABILITY TEST
The porous asphalt contains a large pore network interconnected together, the traditional manner that used to assess the hydraulic conductivity are not directly viable (The Florida Department of Transportation Designation FM 5-565) (FDOT), this test method has been adopted as the standard lab test and the procedure is based on (ASTM PS129-01). The main difference between the FDOT and modified test is that the FDOT test uses an epoxy resin to seal the sidewalls of the marshall specimen, and the modified test uses a flexible latex membrane, this test can use sample formed into marshall mold for testing (Harris et al., 2007), (ASTM D6931)

The lab permeability apparatus consists of aluminum cylinder with 130 mm length and 110 mm inner diameter. This aluminum cylinder has rubber sleeve inside it to prevent horizontal flow and make the flow vertically down. The portion above the aluminum cylinder plastic covers and fixes stand tube pipe, the stand pipe contains scale in inch unit and is at the down valve with same diameter of stand pipe, the stand pipe is 15 in length and 1.5 in diameter. At the first package any air between the aluminum cylinder and the rubber by using vacuum machine to ensure that specimen was put inside the rubber, the specimen put inside the rubber and covered by stand pipe after supported it by using two fixed bolts to prevent the specimen from taking out the rubber at the time of air press between the cylinder and rubber to ensure vertically flow. Adding water from the stand pipe to fill the cell of the sample. The sample was preconditioned by allowing for water draining to outside via the pipe to devoid the sample from any air pockets (bubbles) and be ensured that the saturation of the sample is completely. Firstly, the valve is closed then open, when closing the valve the pipe is filled with water and the time required to fall the water from the initial head (h1) to the final head (h2) was recorded in seconds (t). The repetition of this procedure was three times and a value of (t), (h1) and (h2) was taken for the average. The apparatus of laboratory permeability is shown in figures (1) and (2). The coefficient of the permeability (K) was calculated depending on Darcy’s law falling head permeability test, using the following equation:

\[ K = \frac{a}{A} \frac{L}{t_2 - t_1} \ln \frac{h_1}{h_2} \]

Whereas:
K: permeability coefficient, (cm/s).
a: a cross sectional of test tube, (cm2).
L: thickness of specimen, (cm).
A: a cross sectional of specimen (cm2).
h1: initial head (in).
h2: final head (in).

t1 and t2: time corresponding to h1 and h2, respectively, (s).

The water used into the test must be placed at temperature of 68 °F (20 °C), so as to use a Darcy’s law falling head permeability test.

3. FIELD PERMEABILITY OF POROUS PAVEMENT

The field permeability device have five requisite designs, two of them were commercial manufacturing and the other three were designed by National Center for Asphalt Technology (NCAT) or modified versions of this device.

And the only difference in these apparatuses is the sealant that used to fix the permeability device to the pavement. Each apparatus used the falling head method and made the following expectations: specimen thickness is equal to the immediate underlying PA course thickness, the area of the tested specimen is equal to the area of the permeability device from which water is allowed to penetrate into the porous asphalt, one dimensional fluid flow, steady-state flow and laminar fluid flow (Harris, 2007).

The locally fabricated Modified NCAT permeability device see figure (3), single standpipe attached to a base plate. The modification from the original NCAT design was increasing the diameter of the base plate to create a better seal between the base and the porous pavement. A similar technique to the previous NCAT permeability device was used to seal the device to the testing location. Silicone rubber caulk was placed on the base plate and the base is pressed into the pavement to ensure the water fell down into the pavement without spread from side. If the seal is not adequate, foam will be used to prevent the case of turbulent flow and ensure the flow vertically down. A circular weight was then placed on the base plate to keep the device from lifting after water has been placed in the standpipe. This test can be done with the same steps to calculate permeability in the laboratory. The coefficient of permeability k was estimated by using the Darcy’s law falling head permeability test by equation 1.
4. RESULTS

4.1. The Effect of Additives Content on Lab. Permeability Test

For the PPV the best ratio of the additive content for laboratory hydraulic conductivity is 6 % (5.88) from the asphalt content weight. For the SBS the best ratio of the additive content for laboratory hydraulic conductivity is 8 % (6.1) from asphalt content weight. For the LDPE the best ratio of the additive content for laboratory hydraulic conductivity is 2% (7.55) from the asphalt content weight. See figure (4). The total number of the permeability specimen is (45) specimens, three specimens for each five ratios of the additives content.

![A Sketch of field permeability device](image1)  ![B Field permeability device above PA](image2)

**Figure 3** Field permeability test.

![Figure 4 Effect of additives content on laboratory permeability test.](image3)

In case of the PPV the results of the optimum limit value for the laboratory permeability is decreased 17 %, by using SBS the results of the optimum limit value for the laboratory permeability is decreased 15 % and by using the LDPE the results of the optimum limit value for the laboratory permeability is decreased 5 % from the control asphalt content value. See figures (5).
4.2. Coefficient of Permeability Result with Air Voids Samples

The relationship between the permeability coefficients and the void contents in the mix shows the voids contents increase as permeability coefficient increases. See figure (6).

4.3. Field Permeability

In case of the PPV the results of the optimum limit value for the field permeability is decreased 9 %, by using the SBS the results of the optimum limit value for the field permeability is decreased 7 % and by using the LDPE the results of the optimum limit value for the field permeability is decreased 3 % from the control asphalt content value, see figure (7).
5. CONCLUSIONS

1. The coefficient of permeability in the laboratory increase with air void increased, but this coefficient decrease if asphalt cement mixing with polymer. The purpose of mixing with polymer to increase strength of mixture and resistance the factors due to change in temperature, at using three optimum polymer content 6 % PPV, 8 % SBS and 6 % LDPE the percent of decrease the hydraulic conductivity and air void form control asphalt content mixture are (17, 15 and 5) (41, 28 and 38) %.

2. The coefficient of permeability in the field decrease if asphalt cement mixing with polymer, at using three optimum polymer content 6 % PPV, 8 % SBS and 6 % LDPE the percent of decrease the hydraulic conductivity form control asphalt content mixture is (9, 7 and 3) %.

3. Porous asphalt encourages direct infiltration of stormwater thus reducing the flood in short duration and adverse environmental effects of evaluation large impervious parking lots.

4. Generally, modified mixtures using 6 % PPV, 8 % SBS and 6 % LDPE as an additive, PPV is given more resistance to drain loss to maintain on bonding between asphalt and aggregate, SBS is given strength to the mixture by increase the value of indirect tensile test, LDPE have better performance for all loss abrasion test and permeability.

REFERENCES


