Experimental Study of Porous Paving Using Kalimantan Local Materials

Y Pranoto[1,*] A Sudibyo[1] E R Rivelda[1]

Civil Engineering Department, Samarinda State Polytechnic, 75131, Indonesia
[*]Corresponding author. Email: yudipranoto@polnes.ac.id

ABSTRACT
Floods in Samarinda occur every year. It's because the infiltration area is getting narrower, the drainage conditions are full of garbage, high rainfall, and the behaviour of people who litter. So, it needs improvement technology to reduce these problems. One way is to make porous paving that can absorb water from the soil surface into the ground of soil, use local materials. The purpose of this study was to investigate the effect of local Kalimantan material on the strength and porosity of porous paving. This research processed fly ash as a cement replacement of porous paving at dosage of 10% by weigh of cement, with variation of fine aggregates 0%, 2.5%, 5%, and 7.5%. Test result indicated that the maximum compressive strength in the addition of 7.5% sand with the compressive strength of porous paving is 11.6 MPa, while for the highest porosity of paver with the addition of 0% sand.

Keywords: *Porous Paving, Compression Strength, Porosity.*

1. INTRODUCTION

East Kalimantan have two big problem. First Floods occur every year, and second is unit price of concrete is very expensive. The main problem is around Samarinda city there are many coal mines, which causes sedimentation in the drainage. Also, the infiltration area in Samarinda has decreased due to many road constructions using rigid pavements. To increase the water infiltration area, in this study, we try to use a porous paver. Porous pavers (porous pavers) are soil surface covers that can seep water flow into the soil layer below[1][2][3][4]. There has been a lot of research on porous paver. Patil et al[5][6], researching about geo polymer concrete paver on medium traffic condition highway and also study about cost effective for production of high strength geo polymer concrete masonry block. Abdul Gani et al[7][8], study about effect of recycle aggregate size on drainage and also about effect of thermal for porous pavers. From the research shown that the construction of pervious pavers using recycled aggregates with epoxy binders is suitable for pedestrian and light traffic usage. And the others is the higher void structure in the pavers will cause faster infiltration but contributing to the higher thermal performance. Nazari et al[9], study about void distribution pattern between OPC-based and geo polymer concrete. From the result shown that geo polymer concrete shows less bleeding than OPC concrete, making it a suitable alternative for pavement. Kumutha et al[10], study about properties of I shaped paver block using fly ash based geo polymer concrete. I shaped can used for light and medium traffic if based from compressive strength, but if use flexural strength paver block can be used for heavy duty or industrial roads. Study about a waste combustion of coal and sugar cane bagasse ash in geo polymer paving with steam curing. The result shown that with adding SCBA it will degrade quality of paving[11]. Study about using fly ash to adding for paver porous to replace cement materials to reduce cement to the concrete. From the research fly ash can replaced some cement, but addition of fly ash will reduce the concrete strength [12][13]. This research also support with another research by Nurzal, Bozale, and also Widjaya [14][15][16]. The other research also do by Hadori et all, they use local material Kalimantan with addition of Superplasticizer to increase concrete strength [17][18][19].

2. MATERIALS

Concrete brick is a mixed between cement, fine aggregate, coarse aggregate, and water, with or without additives that do not reduce the quality of concrete brick. the concrete brick must have physical properties shown in Table 1[20].

Table 1. Physical Properties

Quality	Compressive Strength (MPa)		Ave-rage	Min	Maximum of water absorption (%)
	Ave-rage	Min			
A	40	35	0.090	0.103	3
B	20	17	0.130	0.149	6
C	15	12.5	0.160	0.184	8
D	10	8.5	0.219	0.251	10

Remarks:
Quality A = used for road
Quality B = used for parking
Quality C = used for pedestrians
Quality D = used for parks and other uses

Porous paver is concrete that has pores or cavities in its structure, allowing the fluid to flow through the holes contained in the concrete. The aggregates used are only coarse aggregates or with slightly fine aggregates. The cement water factor must be maintained in such a way that once the concrete is hardened the pores are formed not covered by a mixture of hardened cement paste. Also, the control of the cement water factor also aims to make aggregate grains strongly bonded to each other.

Fine aggregate, in this research use Mahakam sand from local Samarinda, east Kalimantan. The variation of Mahakam sand 0%, 2.5%, 5%, 7.5% and 10%. Its size varies between number 4 until number 10. Good fine aggregate must free from waste, and clay. The coarse aggregate use Senoni aggregate, also from Samarinda, East Kalimantan. The aggregate stone having maximum size of 10 – 12 mm. Fly ash use from local Kalimantan. The percentage of fly ash use 10% from cement content. Water must clean from oils, salt, organic materials or other materials can reduce the strength of concrete.

3. METHOD

This research method begins with literature review from various journals, then proceed with material procurement and material testing. After the material properties are obtained, then make a mixed design and a test object. Then after the age of the test object, it is enough to carry out tests in the laboratory, compressive test, porosity test, and permeability test. The last stage is to do analysis and conclusions. This research use 10% of fly ash, and variation of Mahakam sand 0%, 2.5%, 5%, 7.5% and 10%. The targeted of porous paver compressive strength in this studi is 17 MPa at 28 days. Material testing used Indonesian Standard, and also for compressive strength was based on the minimum quality standard paving concrete by SNI 03-0691-1996)[20]. The porosity value can be calculated by using Equation 1, Permeability Equation 2, and compressive strength Equation 3.

$$Porosity = \frac{B - C}{B - A}\ x\ 100\% \quad (1)$$

With:

A = Sample weight in water (gr),

B = Sample weight in SSD condition (gr),

C = Oven-dry sample weight (gr).

$$\frac{dq}{A.dt} = k\frac{dh}{L} \quad (2)$$

With:

$\frac{dq}{dt}$ = Water flow discharge (m3/dtk),

A = Section of area (m2),

dh = High water falls (m),

L = Depth of penetration (m),

K = Permeability coefficient (m/dtk).

$$f'c = P/A \quad (3)$$

With:

f'c = Compression strength (MPa),

P = Maximum load (N),

A = Section area (mm2).

The porous paver block chosen for the present investigation is beam- shaped porous paver block having a dimension of 200 X 100 X 60 mm (. The aspect ratio of the block is the ratio between the Length (L) to the Thickness (T) of the concrete porous paver block (L/T). Samples are prepared in order to determine various properties such as density, compressive strength, flexural strength, water absorption, and abrasion resistance. The number of test specimens is 80 for the compressive test and 15 specimens for the water absorption test. The test object will be compressed at the age of 7, 14, 21, and 28 days, while the water absorption test will be at the age of 28 days. The test object consisted of various variations, namely variation 1 (PS 1 with a content of 0% sand), PS 2 (2.5% sand), PS 3 (5% sand), PS 4 (7.5% sand) and PS 5 (10% sand).

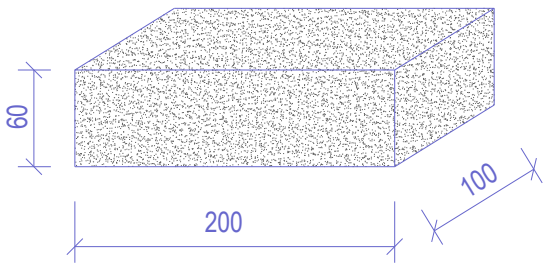

Figure 1 Porous paving specimen

Mixing process of paver porous is mix coarse aggregate, fine aggregate, cement, fly ash and also water, and make sure the mixture is homogeneity (Figure 2). All

specimen has finished the manufacture shown in Figure 3. The specimen must be curing at the laboratory and oven curing at 60°C for 24 hours.

Figure 2 Porous paving manufacture process

Figure 3 Porous paving after manufacture

4. RESULT AND DISCUSSION

4.1. Compression test

The result of compressive strength paver porous at 28 days of all samples are shown in Table 2 and Figure 4. From the table shown the average of compressive strength at 28 days is 10.62 MPa.

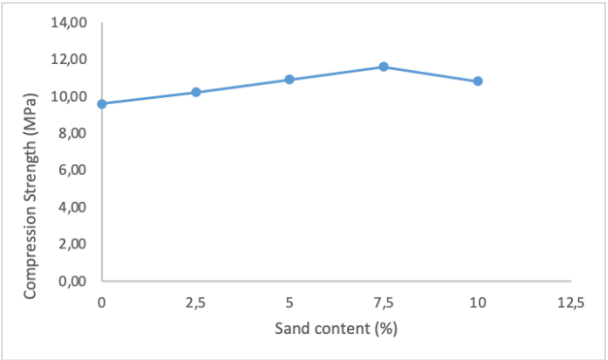

Figure 4 Average compressive strength of porous paving

From the compressive strength test result shown that the maximum compressive strength is 11.6 MPa, and the minimum is 9.6 MPa. From the graph (Figure 4) also shown that with additional of sand will increase the compressive strength.

4.2. Porosity test

The optimum porosity of porous paver is 3.97 % with 0% sand, and the minimum porosity is 3.06% with 10% sand. From the graph (Figure 5) shown that with additional of sand will reduce porosity of porous paving.

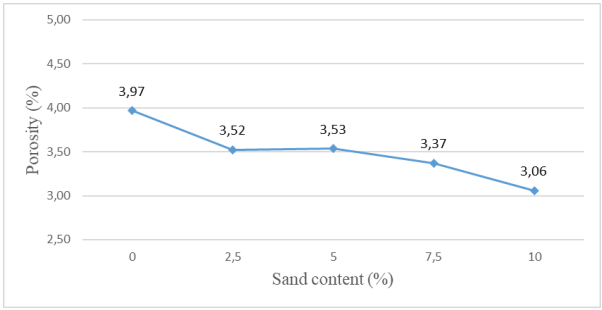

Figure 5 Average porosity of porous paving

5. CONCLUSION

Based from the result can be concluded that the maximum of compression strength is 11.6 MPa with addition of 7.5% sand. While the minimum is on paving with 10% sand content. The addition of sand will increase the compressive strength. The maximum porosity is 3.97 % with 0% sand. From these results, it can be concluded that The addition of sand will increase the compressive strength, but will reduce the porosity. This is because the sand fills the cavities in the paving.

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