Previous concrete as one of the technology to overcome the puddle

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Abstract. Some construction waste has been utilized as a material in certain concrete compositions for engineering building materials. One is a concrete that has been removed after testing at a laboratory called recycle concrete. Disposed concrete, crushed and filtered with filter number 50; 37.5; 19; 9.5; and 4.75 mm are subsequently converted into rough aggregate materials in the manufacture of pervious concrete to be tested for compressive strength and infiltration velocity to water. Pervious concrete test specimens in the form of cylinders with dimensions (15 x 30) cm and plate-shaped with dimension (100 x 100 x 10) cm with the quality plan Fc '= 15 MPa at age 28 days. The research methodology consisted of testing of wear, test object preparation, periodic maintenance, visual inspection, compressive strength testing, and infiltration rate of specimens against water (based on ASTM C1701). Treatment of specimens by spraying periodically before the test time. From the results of the Los Angeles wear test, it appears that recycled aggregate has an average wear rate of 20.88% (based on SNI 03-2417-1991) on the Los Angeles test) and the visual test on the specimen is appropriate (based on SNI 03 -0691-1996 on paving block) as the basis for testing the specimens. The largest compressive strength was found in pervious concrete with 9.5 mm graded aggregates of 5.89 MPa, while the smallest compressive strength of 50 mm gradation was 2.15 MPa and had a compressive strength of 28% of pervious concrete compressive strength on generally (based on SNI 03-6805-2002). The fastest infiltration speed occurs in 50 mm pervious gradient concrete at 4.52 inc / hr and is late in 9.5 mm grading of 2.068 inc / hr or an inflation rate inflation rate of 54.25% for gradation of 9.5 mm to 50 mm gradation , So that in accordance with the purpose of pervious concrete use, concrete that can drain water to the bottom layer

1. Introduction

Indonesia is a country that has two seasons, the rainy and dry. In the rainy season, building structures in Indonesia, such as highway structure buildings (flexible type), will suffer damage to the layers. Of course this will adversely affect road users, can even lead to accidents. Certainly this resulted in the hampered economic pace.

Asphalt is one of the components used in highway structure. However, the weakness of the asphalt to water, led to the conclusion that asphalt is not the best element for highway building components. When it rains, the water will inundate the surface of the paved road, so that the Highway structure will be easily damaged when the loads work. This event concludes that water can damage the ability of asphalt to bind aggregates. Faced with this problem, a new technology is developed on concrete known

as Pervious Concrete Technology. This technology has been around for a long time, around the 17th century, but the technology was developed in the 20th century. Pervious concrete is also called No fines concrete or the other name is non-sand concrete which is a simple form of lightweight concrete, which in its manufacture does not use fine aggregate (sand). The absence of fine aggregates in the mixture produces porous concrete so that the weight is reduced (Ir Kardiyono Tjokrodimulyo, 2009). Pervious concrete is a concrete formed from a mixture of cement, coarse aggregate, water with added materials or admixture. This concrete is made by using a little fine aggregate or even eliminating the use of aggregates (Van Midde & Son Concrete, 2009). This technology produces a concrete that capable of draining water on its surface directly to the underlying layer, since its structure has pores between the bonds of its aggregates

When building a highway building structure with asphalt materials, we also have to build drainage for the water to flow so that the water will not flood the asphalt. But when pervious concrete is used, in this case, the stage of drainage development is not necessary, because the water will flow directly into the pores of the concrete and will go straight to the ground, so there will be no puddles on the surface of the highway. In addition, in terms of hydrology, it is beneficial to supply water reserves in the soil during the rainy season, so it can feed the organisms around the road and the availability of water for society consumption.

Figure 1. Pervious Concrete
source: kompasiana.com

When viewed from its composition, pervious concrete has cement, coarse aggregate, water and a little sand for strengthening. The percentage of cement water is ranged from the ratio of 0.28 - 0.40 with the cavity rate of 15-40%. The amount of water used in the manufacture of this concrete needs to be considered, because less water will increase the strength of the concrete, but can cause failure on its surface. This concrete has a strength of 600 pounds per square inch (4,100 kPa) to 1,500 pounds per square inch (10,000 kPa). In this study, this concrete will be tested for its strength for non structural buildings such as pedestrian area (concrete quality C SNI 03-0691-1989), with heavy strength of K180,72 or fc '15 MPa and infiltration rate. In this concrete material, it will be tried by utilizing recycled aggregate (concrete remnants of test result) with 100% percentage against coarse aggregate value.

2. Literature Review

2.1. Concrete

The word concrete in Indonesian is derived from the Dutch word which is concrete and according to Indonesian Dictionary the concrete is a mixture of cement, gravel, and sand stirred with water for house poles, pillars, walls, and so on. While in English, concrete is known as concrete while in Latin concretus means to grow together or combine into one. In Japanese, the concrete is called the kotau-zai, which literally means the bone-like materials; probably because the aggregates resemble animal bones.

The concrete formation system is the coarse aggregates (split), and filled by small rocks (fine aggregate or sand), and the pores between the fine aggregates are filled by cement and water (cement paste). The cement paste serves to glue or bind the coarse and fine aggregates in the hardening process, so that the aggregate granules are strongly bonded together. From its vast use and its advantages, it can be concluded that concrete structures have many advantages over other structural materials

2.2. Pervious Concrete

Pervious concrete, also called No fines concrete or non-sand concrete, is a simple form of lightweight concrete, which in its manufacture does not use fine aggregate (sand). The absence of fine aggregates in pervious concrete mixture produces porous concrete so that the weight is reduced (Ir Kardiyono Tjokrodimulyo, 2009).

2.2.1. Nature of Pervious Concrete (Porous Concrete)

a. Compressive Strength

In general, the strength of pervious concrete at 28 days old ranges from 3.5 MPa ¬ 28 MPa (5000 - 4000 psi) to 17 MPa as a special value. Since there is no standard for manufacturing that develops anymore, through a core method it is considered to be reliable for measuring the strength of pervious concrete.

b. Infiltration Rate

The rate of infiltration is directly proportional to the number of cavities between the aggregate bonds on the water-passed concrete. The more the number of cavities the greater the rate of infiltration, otherwise the less the number of cavities the smaller the rate of infiltration. The rate of infiltration in inches / hour is done by using a 12-inch diameter infiltration ring and its test method is based on ASTM C 1701 / ASTM C 1701M-09.

2.3. Constituent Materials of Pervious Concrete

2.3.1. Portland Cement

Portland cement is a hydraulic binder produced by grinding clinker consisting of hydraulic calcium silicate, which generally contains one or more forms of calcium sulphate. Generally, portland cement has cement bonding time constraints as follows:

- Initial bind time > 60 menit
- Final bind time > 480 menit

Early initial binding time required in concrete workmanship, ie transport time, pouring, solidification, to surface leveling.

2.3.2. Agregates

In the manufacture of concrete, the use of aggregates is required, since the aggregate is the material that is interlocked by the cement adhesive in the concrete mix (CUR 2, 1993). Aggregate content in concrete mixture generally ranges from 60% -70% of the volume of concrete. Concrete material technology regulates a system that the aggregate must be graded precisely to produce a function of concrete mass as a dense, solid, and homogeneous body. Aggregates can be divided into two types: natural and artificial aggregates (fractions). Both are distinguished by their origin, weight, diameter, and surface texture.

2.3.3. Coarse Aggregate of Recycled Products

Coarse aggregate is a gravel in the result of natural desintergration of rocks or in the form of crushed stone obtained from breaking stone activities with a grain size more than 4.75 mm. In its usage, gravel must meet the following conditions, ie:

1. The mud content is less than 1%, if it exceeds the requirement, then washing is required.
2. Does not contain substances that can damage rocks such as substances that are active against alkali.
3. The flat-shaped aggregate can be used in the manufacture of concrete with a condition of less than 20%.
4. The grains are hard and not porous and are eternal due to the effects of weather and sunlight.


a.


b.

Figure 2. Fractional Concrete Waste (a. Crushed fractional concrete waste; b. Fractional concrete waste to be sieved)

2.3.4. Water

In the manufacture of concrete, water serves as a mixing agent between cement and aggregate. Water used should not contain alkaline, acids, and oils. Similarly, water containing rotting plants should be avoided as they may interfere with the binding of cement. In general, a good water in the manufacture of concrete is a drinking water and does not contain sulfates (Oglesby, 1996). According to PBI 1971, water used as a mixture of building materials has the following requirements, ie:

1. Water used for the manufacture of concrete should not contain oil, alkaline acids, organic materials, salts, and other materials that can damage the concrete.
2. The amount of water used in the mortar can be determined by the weight and must be done appropriately.
3. If it seems necessary to be taken to the Materials Research Laboratory to obtain test accoding to the conditions.

2.3.5. Retarder

Retarder is a chemical to slow down the binding time so that the mixture will remain workable for a longer periods of time so as to avoid the impact of the downturn at the time of casting. The work mechanism of the retarder is wrapping the cement grains with OH- thereby slowing the initial reaction of its hydration and the formation of salt (Ca) in water reduces the concentration of Ca ions thus slowing crystallization during the hydration phase.

Figure 3. *Retarder*

Temperatures as high as 300C-320C or more often lead to faster hardening, which results in the difficulty of pouring and settling. One way to overcome it is by lowering the temperature by cooling the water or aggregate or both.

2.4. Samples Test

Testing of samples performed on pervious concrete is compressive strength test according to SNI 03-6805-2002 and infiltration rate according to ASTM C 170.

2.4.1. Wear Test

Wear testing is a test performed to determine the percentage of recycled coarse aggregate weariness using a los angeles machine and a bullet shaver or steel ball as an auxiliary value to destroy aggregates. If the coarse aggregate wear percentage result is greater than 40%, the aggregate is not good as a pavement, otherwise if the aggregate wear percentage is less than 40%, the aggregate is good as a pavement material. The gravel class type tables for the los angeles experiments and the number of bullets based on the gravel class are as follows:

Table 1. Gradation and Weight of Samples

Sieve Size		**Weight and Gradtion of Samples (Gram)**						
Pass (mm)	**Restrained (mm)**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
76,2	63,5					2500		
63,5	50,8					2500		
50,8	38,10					5000	5000	
38,10	25,40	1250					5000	5000
25,40	19,05	1250						5000
19,05	12,70	1250	2500					5000
12,70	9,50	1250	2500					
9,50	6,35			2500				
6,35	4,75			2500				
4,75	2,36				5000			
Number of Balls		12	11	8	6	12	12	12
Balls Wight (gram)		5000	4584	3330	2500	5000	5000	5000

(Source : SK SNI 2417–1991)

2.4.2. Compressive Strength Test

In this test, the concrete cylinder must have a flat surface, the ribs are not easily braided with the strength of fingers. All this is done by flattening the surface of the cylinder as before 1 hour from pouring the concrete into the cylindrical mold with the tool of a spoon of cement. The steps of compressive strength test are as follows :

1. Take 15 samples and place them into the press machine.
2. The ready test sample is pressed until it is crushed with a pressurized machine which speed can be adjusted from the beginning of the supression of a sample until it is crushed for 1-2 minutes.
3. The compressive strength is calculated by the following formula:

$$Compressive\ strength = \frac{P}{L} \quad (1)$$

Keterangan : P = compressive load (N)

L = compressive plane area (mm^2)

The average compressive strength is calculated from the sum of the compressive strength of the entire test samples divided by the number of test samples.

2.4.3 Infiltration Rate Test

The infiltration rate test is carried out by pouring water into a prepared ring with a diameter of 30 cm and a height of more than 15 mm and placed on top of the plate-shaped pervious concrete then calculate the infiltration rate based on ASTM 1701.

3. Method

The method used in this research is experimental method. The factor under study is the use of recycled aggregates as a substitution of the coarse aggregate to the strength of pervious concrete. The use of recycled aggregates is based on the development of environmentally friendly construction materials technology where the technology is intended to utilize concrete wastes resulting from the remnants of

concrete test results. Manufacture of test samples and quality test procedures is in accordance within the Indonesian National Standard (SNI 03-0691-1996) [7].

4. Result and Discussion

Of all the tests performed, datas obtained are as follows:

a. From the results of the examination showed that the use of recycled aggregates as a substitution of the coarse aggregates on the pervious concrete of some variations produces a hollow and solid plane surface.
b. From the test results above, it is concluded that the coarse aggregate is good for pavement because the average wear percentage is 20.8%, so it is smaller than 40%.
c. If compared with pervious concrete in general, then the pervious concrete by using recycled coarse aggregate is only has a compressive strength of 28% of the pervious concrete compressive strength in general.
d. From the water infiltration rate results table, it is found that pervious concrete with 50 mm gradation is a test sample that has the largest infiltration rate compared to other gradation that is equal to 4.52 inc / hr, and pervious concrete of 9.5 mm gradation is a test sample that has the lowest infiltration rate value compared with other graded samples that is equal to 2,068 inc / hr based on ASTM C 1701 infiltration.

Conclusion

From the results of the research and the results of the discussion that has been done, it can be concluded things as follows:

a. Based on SNI 03-2417-1991, recycled aggregate has an average wear percentage of 20.88% and for visual test and size on pervious concrete is already in accordance with SNI 03-0691-1996 so the test can be done.
b. The largest compressive strength is in pervious concrete with recycled aggregate with 9.5 mm gradation which is 5.89 MPa, while the smallest compressive strength is on 50 mm gradation which is 2.15 MPa and has only a compressive strength of 28% of pervious concrete compressive strength in general, so that a pervious concrete using a sandless recycled aggregate does not meet the standard of paving block quality based on SNI 03-0691-1996.
c. The fastest infiltration rate is on 50 mm gradation which is 4.52 inc / hr and the slowest is on 9.5 mm gradation that is equal to 2,068 inc / hr so it is equal to 54,25% of infiltration rate of 50 mm gradation.
d. To obtain a good quality of concrete in accordance with the expectation, then, the planning, methods of work, accuracy, maintenance, tools and materials, must be implemented properly in accordance with the guidelines

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