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Experimental Study Of Ready Mix Wastewater Utilization For New Concrete Mixtures

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Abstract

The use of waste water that is still in accordance with the standards of SNI 06-6989 and APHA 3120B can be reused as a concrete mixture material in the concrete production process at the Batching Plant, especially for low-quality concrete. The purpose of this study was to determine the effect of the use of wastewater with variations of 0%, 25%, 50%, 75% and 100% on the quality or quality of concrete. Based on the results of the study, it was found that at the beginning of the concrete pavement period, the chemical content contained in wastewater from the concrete production process will interfere with the hydration process so that the compressive strength of concrete at the age of 7 days tends to decrease. However, after the age of 28 days, the dissolved solids in the wastewater from the concrete production process fill the pores in the concrete so that the compressive strength of the resulting concrete becomes higher. The value of the use of wastewater to the optimal composition of the concrete mix design is 75% of the total volume of water required. This is based on the results of the compressive strength test which reached 93.37% of normal concrete at the age of 7 days, 100.59% of normal concrete at the age of 14 days and 105.94% at the age of 28 days with the slump and flow table test results of 16cm and 38cm.

Keywords
Compressive Strength, Flow Table Test, Slump, Wastewater.

1. Introduction

In improving technological progress, the use of concrete as a building is very popular in Indonesia (Hepiyanto and Kartikasari 2018). Batching Plants PT Wijaya Karya Beton Tbk can produce ready mix concrete every day with high intensity, reaching 700-1000 m3 per day to achieve the target that has been scheduled by the project. Operational activities with high productivity will have various impacts, both positive and negative impacts on the environment. To prevent negative impacts on the environment arising from production activities, it is necessary to have a construction technology that can reduce the exploitation of nature and can utilize concrete wastes. Soelarso and Baehaki (2016) Management of this impact on the environment is a very effective way to implement environmental-friendly national development in order to create sustainable development.

Another problem that needs to be observed is the presence of waste water from the concrete production process which is quite large in the concrete production process, which is 28 m3 per day. This phenomenon can be seen clearly in a large capacity batching plant with a mixer capacity of 270 m3/hour. This waste comes from washing the pan mixer after the production of concrete at the batching plant and from washing the truck mixer after distributing the concrete from the batching plant to the construction site. This often causes various problems to the environmental ecosystem around the batching plant, such as residents' rice fields, residents' houses, and residents' drainage channels which hampers the production process due to claims made by residents, community organizations and related environmental services.

As a solution, it is necessary to have a solution for the use of wastewater that still meets the requirements of SNI 06-6989 and APHA 3120B to be used in the manufacture of new concrete. The use of wastewater from the concrete production process in new concrete can reduce the value of liquid absorption and reduce the value of the sorptivity of the concrete in the concrete itself. The value of the use of wastewater from the optimal concrete production process is 25% of the total volume of water required. With the analysis to be carried out, in the future the wastewater in the water treatment batching plant can be utilized again, in accordance with the application of the 3R system (Reuse, Reduce, and Recycle). Theoretically this is not good for the strength of the concrete itself because the elements contained in wastewater are chemical elements that greatly affect the strength of concrete at a certain level (Armeyn 2015). Before further development, it is necessary to conduct research to determine the effect of mixing wastewater from concrete production on the physical and mechanical properties of concrete. This research will conduct a study related to the effect of mixing wastewater from the concrete production process on compressive strength, and water absorption.

2. Methodology

The method used in this research is experimental, which is a deeper study of the effect of mixing wastewater on the production of new concrete. The materials used in this study were: Portland cement type I, Tayan River fine aggregate, Gunung Mas coarse aggregate with a maximum diameter of 40 mm, Sika viscocrete 8030S from PT Sika Indonesia, water from the Batching Plant Laboratory Section 3 PT Wika Beton , the wastewater comes from the water treatment of the Batching Plant Laboratory Section 3 of PT Wika Beton. The equipment used consists of: (a) compression testing machine, (b) slump test apparatus, (c) air content meter kit (d) Scales.

Testing of the constituent materials of concrete includes testing of aggregate sifter analysis, specific gravity and water absorption, bulk density and voids, organic content, aggregate moisture content, and aggregate silt content.

Variations in the use of wastewater are 0%, 25%, 50%, 75%, and 100% of the amount of water required in normal concrete mixtures. The compressive strength test of concrete was carried out at the age of 7, 14, and 28 days which was carried out based on (SNI 03-1974-1990). The slump test, slump flow table test, concrete density, and air content were carried out when testing fresh concrete.

The design of the concrete mix using the method of the Ministry of Public Works as stated in the SNI. 03-2834-2000 “Procedures for Making Normal Concrete Mixture Plans”.

Table 1. Recapitulation of the calculation of material requirements for 1m^3 of concrete

Material	Unit	Wastewater Percentage				
		0%	25%	50%	75%	100%
Cement	Kg	295.67	295.67	295.67	295.67	295.67
Water	Liter	153.75	115.31	76.88	38.44	0.00
Wastewater	Liter	0.00	38.44	76.88	115.31	153.75
Sand	Kg	782.88	782.88	782.88	782.88	782.88
Aggregate	Kg	1092.31	1092.31	1092.31	1092.31	1092.31
Admixture	Liter	2.96	2.96	2.96	2.96	2.96

3. Result and Discussion

3.1. Result

3.1.1. Aggregate Test Results

Before making the test sample, the material to be used is tested first. The test data will be compiled starting from material testing to the final test of the test object. The test was carried out at the WIKA HSRCC Batching Plant 3 Walini which was carried out using the equipment in the laboratory.

Table 2. Fine Aggregate Test Results

Test Type	Sample Result
Specific Gravity	2.64
Water Absorption (%)	1.70
Bulk Density (kg/m3)	1338
Compact Density (kg/m3)	1553
Moistue Content (%)	5.0
Clay Lump Content (%)	2,1
Fine Modulus	2.897
Organic Content	Scale 2

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Table 3. Coarse Aggregate Test Results

Test Type	Sample Result
Specific Gravity	2.69
Water Absorption (%)	1.70
Bulk Density (kg/m3)	1316
Compact Density (kg/m3)	1464
Moistue Content (%)	4.0
Clay Lump Content (%)	2,1
Fine Modulus	7.152

3.1.2. Wastewater Test Results And Analysis

The wastewater test in this study used wastewater from the Wika Beton Water Treatment Batching Plant, and included testing of temperature, pH, suspended solids, dissolved solids, copper, chromium, dissolved iron, dissolved manganese, zinc, BOD, COD, oil. and fats, phenols and MBAS. The results of the wastewater test are shown in the form of a table as follows.

Table 4. Wastewater Test Results

No	Testing Parameter	Sample Result	Regulatory Limit		Unit	Methods
1	Temperature	27	38	40	ºC	SNI 06-6989.23-2005
2	pH	11.9	6	9	-	SNI 06-6989.11-2004
3	Total Suspended Solid	52.7	2000	4000	mg/L	APHA 2540C Ed 23-2017
4	Total Dissolved Solid	892	200	400	mg/L	APHA 2540D Ed 23-2017
5	Copper (Cu)	<0.0839	2	3	mg/L	APHA 3120B Ed 23-2017
6	Chromium (Cr)	<0.0813	0.5	1	mg/L	APHA 3120B Ed 23-2017
7	Dissolved Iron (Fe)	0.542	5	10	mg/L	APHA 3120B Ed 23-2017
8	Dissolved Manganese (Mn)	0.0627	2	5	mg/L	APHA 3120B Ed 23-2017
9	Zinc (Zn)	<0.0189	5	10	mg/L	APHA 3120B Ed 23-2017
10	BOD	16.4	50	150	mg/L	SNI 6989.72-2009
11	COD	43.4	100	300	mg/L	SNI 06-6989.2-2009
12	Oil and fat	<1.38	10	20	mg/L	SNI 6989.10-2011
13	Phenol	0.21	0.5	1	mg/L	SNI 06-6989.21-2004
14	MBAS	0.414	10	20	mg/L	SNI 06-6989.51-2005

3.1.3. Slump Test Results

Slump testing is carried out in order to determine the workability of concrete. Therefore, the workability of fresh concrete is measured from the slump test. The ease of work can be seen from the slump value which is identical to the level of plasticity of the concrete. The more plastic the fresh concrete, the easier it is to work.

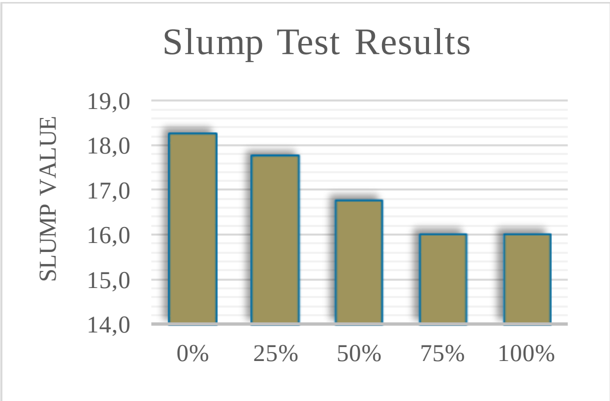

Figure 1. Concrete Slump Test Results

3.1.4. Flow Table Test Results

Slump flow test data, the results can be seen in the following table.

Table 5. Slump Flow Table Test Results

Percentage Variation of Wastewater Mix	Slump Flow Table Test (cm)			Average Slump Flow
	I	II	III	(cm)
0%	40	40	41	40
25%	40	41	41	41
50%	41	41	41	41
75%	38	37	38	38
100%	33	33	34	33

From the table above, it can be seen that the slump flow value for concrete with the higher the percentage of wastewater makes the slump flow value decrease, namely for normal concrete, the slump flow value is 40 cm, while the slump flow value for concrete with the percentage of wastewater mixing is 100% of total water requirement is 33 cm.

3.1.5. Concrete Density Results

Density test results, the results can be seen in the following table.

Table 6. DesntiyTest Results

Percentage Variation of Wastewater Mix	Mass of Measure filled with Concrete (Kg)		Average	Density	Density Plan
	I	II	(Kg)	(Kg/m3)	(Kg/m3)
0%	16.66	16.65	16.66	2379	2380
25%	16.68	16.69	16.69	2384	2380
50%	16.67	16.68	16.68	2382	2380
75%	16.69	16.68	16.69	2384	2380
100%	16.72	16.70	16.71	2387	2380

From the yield test results on each variation of the wastewater mixture, it can be concluded that it does not significantly affect the yield on the concrete itself, the value of each variation of the wastewater mixture is still close to the planned yield value of 2380 Kg/m^3.

3.1.6. Air Content Test Results

In this study, the air content examination that has been carried out has the following results.

Table 7. Air Content Test Results

Percentage Variation of Wastewater Mix	Air Content (%)		Average
	I	II	(%)
0%	3.1	3.3	3.2
25%	3.3	3.3	3.3
50%	3.4	3.6	3.5
75%	3.6	3.5	3.6
100%	4.0	4.2	4.1

From the results of testing the air content in each variation of the wastewater mixture, it can be concluded that the existing air content still meets the requirements, namely the lowest value in normal concrete is 3.5% and the highest air content in concrete with a percentage of 100% wastewater mixture is 4, 1% means that concrete can be used because it does not exceed 6.5%, which is a condition that can reduce the strength of concrete, because there are many cavities. If the air content is less than 2%, it means that the concrete is too hard so that it will be affected in the work in the field, where the hardened concrete will crack due to lack of space for the concrete molecules to move during expansion.

3.1.7. Compressive Strength Test Results

After making and curing the test sample, then the compressive strength test is carried out on the test sample that has been curing in the curring pool. The concrete compressive strength test was carried out when the specimens were 7, 14 and 28 days old as many as 45 specimens, consisting of 5 variations of the mixed percentage of wastewater mixture. For each variation 9 specimens were made in the form of a cube with a side

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size of 15 cm for compressive strength. So that the results of the compressive strength are obtained in the following tables and graphs.

Table 8. Compressive Strength Test Results 7 Days Age

Percentage Variation of Wastewater Mix	Compressive Strength (Mpa)			Average	Conversion
	I	II	III	(Mpa)	(Kg/cm2)
0%	28.1	28.2	27.8	28.0	337.78
25%	26.0	25.5	27.0	26.2	315.39
50%	24.3	24.6	24.5	24.5	294.90
75%	26.2	25.5	26.6	26.1	314.53
100%	24.0	23.8	23.6	23.8	286.63

Table 9. Compressive Strength Test Results 14 Days Age

Percentage Variation of Wastewater Mix	Compressive Strength (Mpa)			Average	Conversion
	I	II	III	(Mpa)	(Kg/cm2)
0%	35.9	36.2	36.0	36.0	434.18
25%	35.9	36.0	35.9	35.9	432.79
50%	31.5	32.0	32.3	31.9	384.74
75%	36.0	36.5	36.2	36.2	436.74
100%	34.1	34.5	35.0	34.5	415.90

Table 10. Compressive Strength Test Results 28 Days Age

Percentage Variation of Wastewater Mix	Compressive Strength (Mpa)			Average	Conversion
	I	II	III	(Mpa)	(Kg/cm2)
0%	37.0	36.2	36.6	36.6	441.03
25%	38.8	38.8	37.5	38.4	462.39
50%	32.5	31.9	32.3	32.2	388.27
75%	38.5	39.0	38.8	38.8	467.21
100%	37.5	37.9	37.2	37.5	452.01

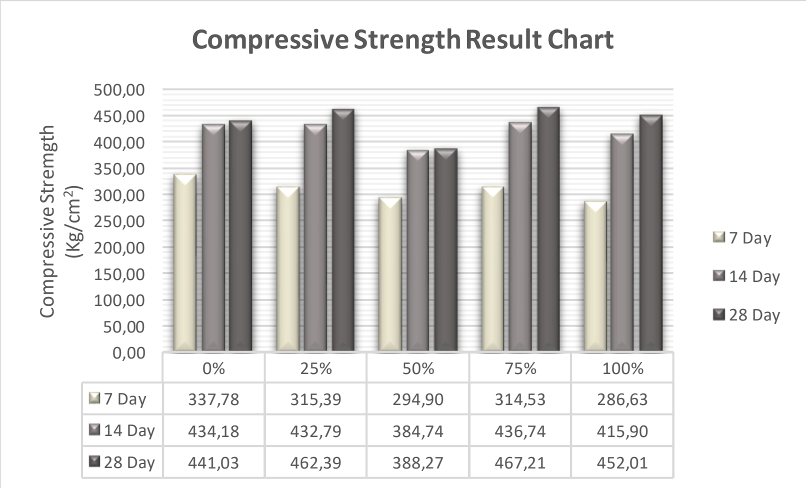

Figure 2. Grafik Hasil Kuat Tekan Beton

Based on the graph, it can be concluded that the effect of mixing wastewater on the decrease in the average compressive strength of concrete at the age of 7 days is between 84.86% - 93.37%, then for testing the average compressive strength of concrete at the age of 14 days, which is between 88.61% - 100.59%, and for testing the average compressive strength of concrete at the age of 28 days is between 88.04% - 105.9%.

3.2. Discussion

At the beginning of the concrete pavement period, the chemical content contained in wastewater from the concrete production process will interfere with the hydration process so that the compressive strength of concrete at the age of 7 days tends to decrease. However, after the age of 28 days, the dissolved solids in the wastewater from the concrete production process fill the pores in the concrete so that the compressive strength of the resulting concrete becomes higher.

Therefore, it can be concluded in this experimental study that the use of wastewater that still meets the standards of SNI 06-6989 and APHA 3120B can be reused as a concrete mix material in the concrete production process at the Batching Plant, especially for low-quality concrete such as project access roads, mini pile and drainage (box culvert).

4. Conclussion

Based on the results and discussions that have been carried out, it can be concluded as follows:

3. At the beginning of the concrete pavement period, the chemical content contained in wastewater from the concrete production process will interfere with the hydration process so that the compressive strength of concrete at the age of 7 days tends to decrease. However, after the age of 28 days, the dissolved solids in the wastewater from the concrete production process fill the pores in the concrete so that the compressive strength of the resulting concrete becomes higher.
4. Based on the test results of the average compressive strength of concrete at the age of 7 days, the concrete tends to experience a decrease in compressive strength, which is between 84.86% to 93.37% of normal concrete due to the effect of mixing wastewater. Then for testing the average compressive strength of concrete at the age of 14 days, which is between 88.61% to 100.59% against normal concrete, and for testing the average compressive strength of concrete at the age of 28 days, which is between 88.04% to 105, 9% against normal concrete.
5. The value of the use of wastewater from the optimal concrete production process is 75% of the total volume of water required. This is based on the results of the compressive strength test which reached 93.37% of normal concrete at the age of 7 days, 100.59% of normal concrete at the age of 14 days and 105.94% at the age of 28 days. The results of the slump and flow table tests for mixing 75% wastewater are 16 cm and 38 cm, these results are still optimal, especially for the ease of working on concrete in the field for low quality such as access roads, mini piles, and box culverts.

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