



## **Characteristic of Concrete Using Acetylene Sludge as a Substitute Material for Sand and Cement**

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**Abstract**—Acetylene sludge comes from the production of acetylene gas which is produced in large quantities from industrial plants. Since acetylene sludge waste has a baling and mortar properties as well as lime derivative products, they can be used as substitutes or substitutes for cement in concrete products and other construction materials. The aim of this study is to obtain a concrete with a proper strength and comply the toxicity standards by utilizing acetylene sludge waste. The waste (containing of 60% acetylene sludge and 40% fly ash) is utilized by mixing it on some series of trial that are 5%, 10%, and 15% waste from the main concrete materials. The concrete strength is measured using Compressive Strength Test Method that refers to Indonesian National Standard No. 1974:2011. Other than that, Toxicity Characteristic Leaching Procedure (TCLP) test were also done using Optical Emission Spectrometer to determine the leaching potential from concrete utilization. The concrete paste gave the value of slump 6 and 7 with concrete mixture declined by 15-18 cm. Result showed that the strongest concrete is from the mixture of 15% sand material that was substituted by the acetylene sludge waste with the strength value of 41.9 MPa. TCLP test results were given the value of Barium 0.019 mg/L and Chromium 0.680 mg/L with a pH value of 12.24. Referring to Indonesian Government Regulation No. 101 Year 2014, the quality standards of Barium and Chromium are 35 mg/L and 2.5 mg/L. That showed the characteristic of concrete which is produced from acetylene sludge waste complies the standards and safe for the environment.

**Keyword:** acetylene sludge, concrete, compressive strength test, toxicity characteristic

### **Introduction**

In industrial and fabrication activities, acetylene gas (carbide gas) is used as a welding material for metal connection with metal. This gas serves as a fuel, which in the presence of oxygen will produce a flame with high temperatures that can melt the metal. Waste generated from acetylene gas production process is carbide waste or also known as acetylene sludge. Acetylene sludge comes from the production of acetylene gas which is produced in large quantities from industrial plants. One company that uses acetylene gas to support its production activities is PT. Freeport Indonesia, where the requirement of acetylene gas in this company is very high, so the company established an acetylene gas manufacturing facility. This facility generates 10,890 kg of acetylene sludge per month (PT Freeport Indonesia, 2016).

Acetylene sludge waste is included in the category of hazardous and toxic waste (B3) waste as stated in Government Regulation No. 101 Year 2014 on the Management of Hazardous and Toxic Waste. Until now, acetylene sludge waste generated by PT Freeport Indonesia is utilized as a neutralizer of acid potential from tailings slurry. This will certainly affect the environment, because it will disrupt the aquatic ecosystems. Since acetylene sludge waste has a baling and mortar properties as well as lime derivative products, they can be used as substitutes or substitutes for cement in concrete products and other construction materials. Based on these considerations, it is deemed necessary to conduct research on the study of the concrete characteristic, which is produced from acetylene sludge waste. Acetylene sludge waste is potentially used as a stabilizer because it contains calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ), and when mixed with other materials containing silica ( $\text{SiO}_2$ ), pozzolanic reactions may result in cementation material, which can replace portland cement as a stabilizer (Diana, 2013). Several published research references show that acetylene sludge waste can be widely used for construction materials, such as concrete, brick and other aggregate concrete products.

Therefore, it can be concluded that acetylene sludge is an industrial waste that still has chemical and physical properties that still have economic value to be utilized.

The large amount of silica and alumina available in fly ash and rich content of calcium oxide in lime sludge, make them compatible with each other and can also replace cement. Up to the 25% of replacement of lime sludge and fly ash in cement mortar it gives higher 28 days strength and it is comparatively developing decrease in strength compared to control mortar. However, percentage strength gain with respect to ages is higher compared to lower percentages of replacements of lime sludge and fly ash (Kumar, et.al, 2016). Calcium carbide sludge can improve the compressive strength of the autoclaved fly ash brick. When the content of calcium carbide sludge is more than 15%, the compressive strength will increase significantly. Calcium carbide sludge can improve the flexural strength of the autoclaved fly ash brick. When the content of calcium carbide sludge is more than 15%, the flexural strength will increase significantly. Calcium carbide sludge can reduce the bibulous rate of the autoclaved fly ash brick. When the content of calcium carbide sludge is more than 15%, the bibulous rate will reduced significantly.

Selection of sand and cement as a substituted material, among others, due to the sand has the nature of filling the empty space in the concrete mixture. Acetylene sludge waste in the dry state is expected to fill the void in concrete like sand. So the use of waste as substitution of sand material is tried in this research. The cement material was also substituted in this study in different variations. Cement is a material that causes hard properties in concrete. In addition, cement is also a material containing calcium (Ca) in its composition, especially Portland Cement Type I used in this study. The purpose of this research is: to get the best composition of concrete mixture ratio, seen from the quality of concrete; analyzed the content of toxic materials on concrete products through Toxicity Characteristic Leaching Procedure (TCLP) test.

## Materials and Methods

### Experimental Design

The amount of waste (which are 5%, 10%, and 15%) that will be mixed with the concrete mixture is determined based on consideration of safety and strength factor of concrete as a construction material. The reason of choosing those percentages of waste that will be added to the concrete mixture is based on the previous research by Kumar, et. al. (2016). The optimal compressive strength test value occurs by 1-12% cement component that is substituted by the acetylene sludge waste. The decreasing of concrete compressive strength drastically happens at the 25% cement component that was substituted by the acetylene sludge. Based on that consideration, the percentage range of substitution used on this research is 5-15%.

The percentage of acetylene sludge waste composition used is 60%, while flyash type C based on Thomas (2007) is 40% of the total waste. Type C flyash is used because it is produced from sub-bituminous coal. Mixed design can be seen in Table 1. Mixed design calculation is done by the following formula:

Volume of Concrete	Volume of cement + volume of mixed aggregates + volume of water + volume of air
Volume of Cement	$\frac{\text{Cement mass (kg)}}{\text{Cement density}}$
Volume of Water	$\frac{\text{Water mass (kg)}}{\text{Water density}}$
Water needed	Water mass (Kg) – (50% x AS <sub>wet</sub> Mass)

Table 1. Experimental Concrete Mix Design

Type of Concrete	Acetylene Sludge Waste (kg)	Cement (kg)	Sand (kg)	Gravel (kg)	Fly Ash (kg)	Water (L)
A <sub>0</sub>	-	703.00	492.00	871.00	-	225.00
A <sub>1</sub>	7.79	703.00	467.00	871.00	2.60	221.00
B <sub>1</sub>	15.58	703.00	443.00	871.00	5.19	217.00
C <sub>1</sub>	23.38	703.00	418.00	871.00	7.79	213.00
A <sub>2</sub>	8.84	668.00	492.00	871.00	2.95	221.00
B <sub>2</sub>	17.68	633.00	492.00	871.00	5.89	216.00
C <sub>2</sub>	26.52	598.00	492.00	871.00	8.84	212.00

Note (s):

- A<sub>0</sub> Concrete : Pure concrete without the addition of acetylene sludge waste
- A<sub>1</sub> Concrete : 5% of sand component substituted by acetylene sludge waste
- B<sub>1</sub> Concrete : 10% of sand component substituted by acetylene sludge waste
- C<sub>1</sub> Concrete : 15% of sand component substituted by acetylene sludge waste
- A<sub>2</sub> Concrete : 5% of cement component substituted by acetylene sludge waste
- B<sub>2</sub> Concrete : 10% of cement component substituted by acetylene sludge waste
- C<sub>2</sub> Concrete : 15% of cement component substituted by acetylene sludge waste

### Data Collection and Analysis

The types of data collected in this research are primary and secondary data. The primary data obtained from the research, which came from measuring and analyzing concrete samples. Data that was measured is concrete slump. Measuring the slump done based on Slump Test Method on Indonesian National Standard No. 03-1972-1990. Tools and materials used in the making of concrete paste and slump test can be seen on Table 2.

Table 2. Equipment and Materials used in the experiment

Activity	Method	Equipment	Material
Making of concrete paste	-	electric mollen, manual scales, digital scales, gravel sieve, cylinder concrete mold (15 x 30 cm)	acetylene sludge waste, fly ash, river sand, portland cement type I, gravel, water
Measuring Concrete Slump	Slump Test Method based on SNI 03-1972-1990	slump cone, tick compactor metal plate, ruler	fresh concrete paste
Others	-	levels measurement tools, curing tub	concrete samples

All the materials and method on concrete compressive strength test, pH test, and Toxicity Characteristic Leaching Procedure (TCLP) test can be seen on Table 3. Primary data is collected from every sample variation, which are 5%, 10%, and 15% sand and cement component substituted by acetylene sludge waste. Secondary data is collected from PT. Freeport Indonesia documentary that is the quantity of acetylene sludge waste produced in acetylene gas plant.

Compressive strength test data is analyzed by calculating the average value of three data collected every variation. Toxicity Characteristic Leaching Procedure (TCLP) data is analyzed to determine the toxicity of pollutant by measuring the concentration of heavy metals that contained in the concrete. Also, heavy metals influence on concrete were analyzed based on the concrete age. pH concrete samples is analyzed to determined its influence based on the concrete age.

Table 3. Materials and Methods

Data	Method	Equipment
Compressive Strength	Compressive Strength Test Method based on SNI 03-1974-2011	Concrete Strength Test Machine
pH	pH Meter based on SNI 06-6989.11-2004	Mortar, Pulverizer, Analytic Scale, Beaker glass, Magnetic stirrer, pH meter, Eppendorf Pipette, Sto Watch
TCLP	Toxicity Characteristic Leaching Procedure, based on	Dispenser Pipette, Eppendorf Pipette, Sto Watch, Measurement Glass, Volumetric Flask, Thermometer, TCLP extraction Tube, Agitator, Elect

Data	Method	Equipment
US EPA-902-B-96-001	SEP	Heater, Glass fiber Filter, Spectrophotometer, Au sampler

## Results and discussion

### Concrete paste mixture

A good consistency of concrete paste is obtained on every variation of the mix design. The consistency known from the mixing of the paste in the electric mollen. Based on Indonesian National Standard No. 03-1972-1990 about Slump Test Method, slump is a workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. The purpose of this slump test is to predict the concrete strength from the existing mix design. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. The result of slump test can be seen on Figure 1 with the description on Table 4.



Figure 1. Concrete slump: from right to left A<sub>0</sub>, A<sub>1</sub>, B<sub>1</sub>, C<sub>1</sub> concrete (*up row*), A<sub>2</sub>, B<sub>2</sub>, C<sub>2</sub> concrete (*bottom row*)

Table 4. Concrete Slump Test Result

Type of Concrete	Type of Slump	Concrete Height Declining (cm)
A <sub>0</sub>	7	16
A <sub>1</sub>	7	17,5
B <sub>1</sub>	7	17
C <sub>1</sub>	6	15
A <sub>2</sub>	6	15
B <sub>2</sub>	6	15
C <sub>2</sub>	7	18

Note (s):

- A<sub>0</sub> Concrete : Pure concrete without the addition of acetylene sludge waste
- A<sub>1</sub> Concrete : 5% of sand component substituted by acetylene sludge waste
- B<sub>1</sub> Concrete : 10% of sand component substituted by acetylene sludge waste
- C<sub>1</sub> Concrete : 15% of sand component substituted by acetylene sludge waste
- A<sub>2</sub> Concrete : 5% of cement component substituted by acetylene sludge waste
- B<sub>2</sub> Concrete : 10% of cement component substituted by acetylene sludge waste
- C<sub>2</sub> Concrete : 15% of cement component substituted by acetylene sludge waste

Adding 3 liters of water is done to make easier stirring. This addition of water changed the water-cement ratio from 0.32 to 0.35, but it doesn't affect the amount of cement. The quality of concrete still on 40 MPa. Based on the result on Table 1, this type of slump predicted as a concrete that used as plate, beam, column, and wall according to Indonesian Regulation of Reinforced Concrete (1971) in Nugraha *et.al.* (2007). Based on the shape of the slump, most of it are true slump that shows the composition of the mixture is right and some of it are shear slump that shows the composition is right but the mixing needed more time.

### Compressive Strength Test Result

Concrete compressive strength test is done on the period of 3, 7, 14, 21, and 28 days. This test done based on Indonesian National Standard No. 03-1974-2011 about Compressive Strength Test Method. The result can be seen in Table 5. On the third day of testing, the highest compressive strength was achieved on the type of B<sub>2</sub> concrete with a value of 31.25 MPa, while the lowest compressive strength occurred in C<sub>2</sub> concrete with a value of 20.70 MPa. Thus, the best concrete on the third day is B<sub>2</sub> concrete. The substitution of cement material with acetylene sludge wastes provides less stable compressive strength on day 3 because the results are varied. Compressive strength on this third day has reached 40% of the strength of mature concrete. Under this provision, the compressive strength to be achieved is 16 MPa. Thus, from the analysis performed, the entire concrete reaches the compressive strength.

The seventh day of concrete with A<sub>2</sub> composition gives the highest compressive strength of the other compositions. Based from the developments, on the seventh day, the highest compressive strength is still achieved by the concrete substitution of cement material. Compressive strength on this seventh day has reached 65%, so the supposed strength of concrete is 26 MPa. From the results obtained, only the A<sub>1</sub> concrete does not reach the strength of 26 MPa.

Day 14, concrete with B<sub>1</sub> and C<sub>1</sub> composition still shows stable strength from other variations. Concrete C<sub>1</sub> has a higher strength than B<sub>1</sub> and other variations, which is at 38.40 MPa. The lowest strength occurs in the C<sub>1</sub> concrete variation with a compressive strength value of 31.60 MPa. On the 14th day, compressive strength should have reached 90% of the compressive strength of the design (40 MPa). Thus, the compressive strength on the 14th day has reached at least 36 MPa. From the results obtained, only concrete B<sub>1</sub> and C<sub>1</sub> reach this compressive strength.

Table 5. The Average of Compressive Strength Test Result

Type of Concrete	Compressive Strength (MPa) on day-				
	3	7	14	21	28
A <sub>0</sub>	25.10	29.40	36.35	28.90	29.05
A <sub>1</sub>	26.67	25.30	32.77	36.00	36.80
B <sub>1</sub>	28.43	31.70	36.13	39.10	39.65
C <sub>1</sub>	29.30	30.13	38.40	35.70	41.90
A <sub>2</sub>	23.70	35.00	33.03	30.85	34.80
B <sub>2</sub>	31.25	28.93	34.93	36.80	40.90
C <sub>2</sub>	20.70	26.37	31.60	36.85	31.63

Note (s):

A<sub>0</sub> Concrete : Pure concrete without the addition of acetylene sludge waste

A<sub>1</sub> Concrete : 5% of sand component substituted by acetylene sludge waste

B<sub>1</sub> Concrete : 10% of sand component substituted by acetylene sludge waste

C<sub>1</sub> Concrete : 15% of sand component substituted by acetylene sludge waste

A<sub>2</sub> Concrete : 5% of cement component substituted by acetylene sludge waste

B<sub>2</sub> Concrete : 10% of cement component substituted by acetylene sludge waste

C<sub>2</sub> Concrete : 15% of cement component substituted by acetylene sludge waste

Day 21, there is a compressive strength changes where concrete B<sub>1</sub> has a higher strength than C<sub>1</sub> concrete, although not too much of its value. The lowest compressive strength occurs in the A<sub>2</sub> concrete variation. This A<sub>2</sub> variation of concrete decreased from day 14, while others experienced an increase from the previous day. Thus, this concrete does not show a good compressive strength if it's compared with the other compositions.

Day 28, the compressive strength of concrete should have reached the level of maturity of concrete with concrete strength of 99%. Therefore, the strength of the concrete should have reached 39.6 MPa. Based on the results obtained, the concrete B<sub>1</sub>, C<sub>1</sub>, and B<sub>2</sub> reach the expected strength. When compared, C<sub>1</sub> concrete is stronger than concrete B<sub>1</sub>, thus C<sub>1</sub> concrete is the best quality concrete. By looking at the increase in strength of concrete starting from day one, concrete B<sub>1</sub> and C<sub>1</sub> provide the most stable value. So, by looking at the compressive strength of the 28th day, C<sub>1</sub> is the strongest concrete.

The more waste added in the substitution concrete mixture formula of sand material, the stronger the quality of the concrete. It is still not known the maximum amount of acetylene sludge waste that can be

added in the concrete mixture to obtain the highest concrete quality, until finally the quality of the concrete reaches the break even point and the compressive strength will decrease.

Overall, acetylene sludge waste can be used as a substitute material for sand and cement. However, the best concrete quality achieved occurs in the concrete with sand material substituted by acetylene sludge waste as much as 5%, 10%, and 15% with the concrete strength of 36.80 MPa, 29.65 MPa, and 41.90 MPa. Based on its strength, concrete with cement material substituted by acetylene sludge waste also produces high quality concrete. But when compared with the sand material substituted by acetylene sludge waste, this concrete is not stronger.

The amount of acetylene sludge waste used as cement substitution is not as much as the amount used as a substitute for sand. Reduction the amount of waste is greater when the waste is used as a sand substitute component in the concrete. The greater amount of waste used in the concrete is better in this utilization.

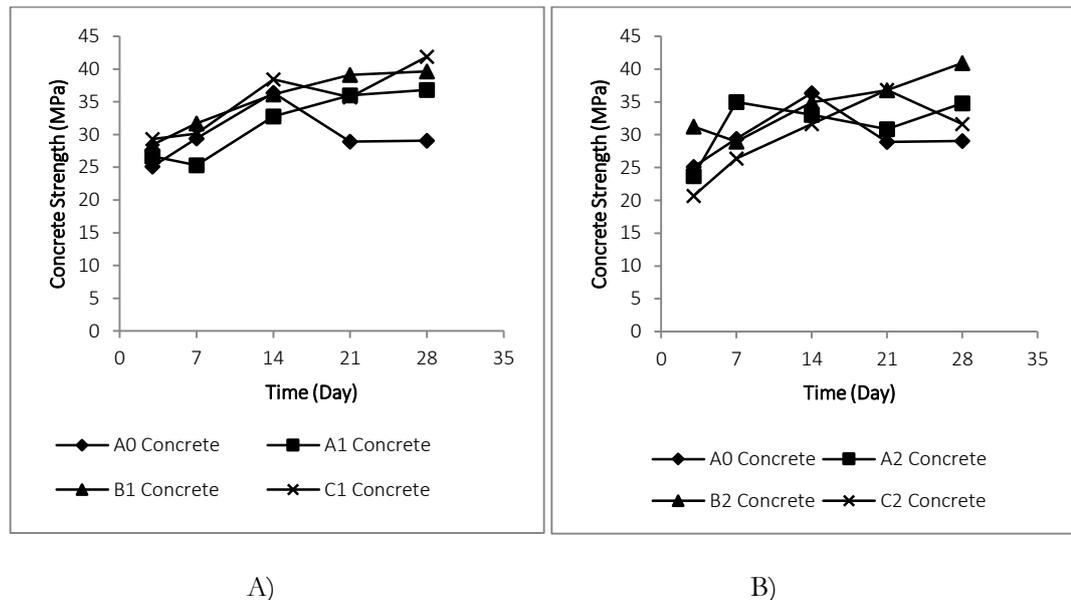


Figure 2. Graph of concrete strength for concrete without addition of acetylene sludge waste with concrete utilized with A) sand material substituted by acetylene sludge waste B) cement material substituted by acetylene sludge waste.

Factors that are expected to affect the compressive strength of the concrete include physical, chemical and human factors. For physical factors are uneven mixing, stirring and molding, less smooth surface, concrete surface level, curing temperature, concrete conditions (Kosmatka, Kerkhoff, and Panarese, 2003). For chemical factors: The reaction of cement hydration between acetylene sludge waste, fly ash, cement, and water (Sun, 2015), also the presence of heavy metals in concrete, which caused the reducing of concrete strength. The presence of this heavy metal will affect the compressive strength of the concrete because heavy metals like water so that the presence of heavy metals can absorb water content. This will affect the compressive strength of the concrete as it interferes with the occurring of cement hydration reaction. To find out if there are heavy metals in the concrete product from acetylene sludge waste utilization, we can see on the TCLP test result and discussion. Further, the carefulness in adjusting the lever during the test of compressive strength is one of the human factor affected the comprehensive strength.

The result study of Kusuma (2013) showed that from the average compressive strength test it can be known that the mixture of the strongest carbide welding waste as the cement mixture for paving block making is at 47% mixture, while for the result of the smallest water absorption test is at 40% and for the greatest yield there is in the 37% mixture. Research conducted by Hartono, et.al (2009) concluded that the highest mortar compressive strength of mixed ash of organic waste and carbide waste was obtained in a mixture of 70% ash of organic waste and 30% of carbide waste at 26.4 kg/cm<sup>2</sup> at 14 days.

### Toxicity characteristic leaching procedure (TCLP) test result

The TCLP test was performed on all of the concrete sample variations for the 3rd, 7th, 14th, 21st and 28th day. The test is based on US EPA-902-B-96-001. The results of this TCLP test showed in Table 6. Barium and chromium concentrations in all variations of the sample component of the concrete give a

varied result. This is shown from the concentration value of TCLP test parameters, which gives fluctuating numbers. In the barium parameter, TCLP test results on day 28 showed very small values in all variations of concrete composition. The substituted concrete of sand and cement material gives different results. In the concrete substitution of sand material, it can be seen that the decreasing value of barium concentration on the concrete A<sub>1</sub>, B<sub>1</sub>, and C<sub>1</sub>, whereas the amount of waste added more and more. While on the concrete of cement substitution, i.e. on the concrete A<sub>2</sub>, B<sub>2</sub>, and C<sub>2</sub>, the barium concentration increases as the amount of waste added.

Table 6. Concrete TCLP Test Result

Parameter	Concrete Sample	TCLP Concentration on day- (mg/L)				
		3	7	14	21	28
Barium	A <sub>1</sub>	0.317	< 0.005	0.689	0.437	0.332
	B <sub>1</sub>	0.165	0.294	0.378	0.322	0.305
	C <sub>1</sub>	0.301	0.053	0.112	0.398	0.019
	A <sub>2</sub>	0.231	0.417	0.536	0.247	0.312
	B <sub>2</sub>	0.490	< 0.005	0.397	0.772	0.355
	C <sub>2</sub>	0.695	0.423	0.667	0.663	0.473
Chromium	A <sub>1</sub>	0.315	0.745	0.220	0.166	0.490
	B <sub>1</sub>	0.769	0.195	0.236	0.023	0.013
	C <sub>1</sub>	0.391	0.360	0.216	0.011	0.680
	A <sub>2</sub>	0.620	0.199	0.209	0.297	0.469
	B <sub>2</sub>	0.308	0.437	0.216	0.281	0.400
	C <sub>2</sub>	0.225	0.029	< 0.005	0.014	0.362

Note (s):

- A<sub>1</sub> Concrete : 5% of sand component substituted by acetylene sludge waste
- B<sub>1</sub> Concrete : 10% of sand component substituted by acetylene sludge waste
- C<sub>1</sub> Concrete : 15% of sand component substituted by acetylene sludge waste
- A<sub>2</sub> Concrete : 5% of cement component substituted by acetylene sludge waste
- B<sub>2</sub> Concrete : 10% of cement component substituted by acetylene sludge waste
- C<sub>2</sub> Concrete : 15% of cement component substituted by acetylene sludge waste

The C<sub>1</sub> concrete sample has the smallest barium concentration value compared to the other six variations. Thus, C<sub>1</sub> concrete is the best concrete seen from the content of barium pollutants. However, based from the value of barium concentration, this concrete is much smaller than other concrete. The barium concentration in this concrete is 0.019 mg/L while the other is in the range of values of 0.3 mg/L to 0.4 mg/L. Concentration of chromium in concrete C<sub>1</sub> has the highest value, whereas in concrete B<sub>1</sub> has the smallest value. Thus, concrete B<sub>1</sub> is the best concrete when viewed from its chromium concentration. However, the concentration of chromium in both concrete has a significant difference, where the smallest concentration is 0.013 mg/L while the largest concentration is 0.680 mg/L.

The varied concentration values, both barium and chromium, may be due to factors other than acetylene sludge waste content and fly ash added to the concrete mixture. Another material that could be the influence factor of pollutant concentration is gravel on concrete mixture. Gravel that has been used mostly consists of limestone and basalt. Based on research conducted by Al-Ansari and Iyengar (2013), limestone content containing BaO as much as 0.097% mass of gravel, while basalt rock containing Cr<sub>2</sub>O<sub>7</sub> as much as 0,104% mass of gravel. The large number of uneven gravel can be the effect of varied barium and chromium concentration values. However, further research is needed to verify whether the gravel component is capable of affecting the concentrations of concrete pollutants.

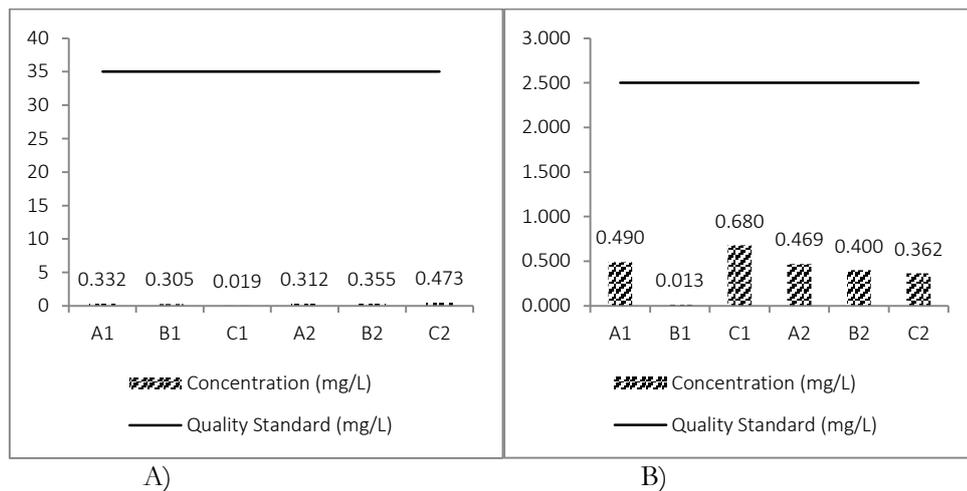


Figure 3 Comparison graph of concentration value of A) barium and B) chromium on Toxicity Characteristic Leaching Procedure test to quality standard.

From these data, we can see whether the concentration of TCLP test parameters from concrete utilization of acetylene sludge waste in accordance with the existing quality standard in Figure 3 for chromium concentration. As a reference, Indonesian Government Regulation No. 101 Year 2014 concerning the Management of Hazardous and Toxic Waste Appendix IV on TCLP test of the standard treatment of hazardous and toxic waste materials. The standard quality of barium and chromium concentrations is 35 mg/L and 2.5 mg/L. This shows that no toxic material found in concrete utilization of acetylene sludge waste and the concrete has no harmful effects on the environment. If the concentration value exceeds the quality standard, it means that there is pollutant mobility from the concrete of acetylene sludge waste utilization. This can endanger the environment, especially since acetylene sludge waste that is used as a concrete will be in direct contact with the environment when applied.

### Concrete pH Test Result

Concrete pH test results showed in Table 7. The pH test is based on Indonesian National Standard No. 06-6989.11-2004 about the pH meter. From the data obtained, the pH value of each concrete variation decreases with the increasing age of concrete. However, the pH value still shows a very alkaline value, which is about 12.2 in the 28-day concrete age. The decrease in pH value can be seen in Figure 4.

Concrete without the addition of acetylene sludge waste ( $A_0$ ), also has a very alkaline pH. Thus, the pH on the concrete utilization results will not have an impact when the application is in the field. Also note that concrete mixtures with this pH will not be directly used at the time of application in the field. In general, there are additional chemicals (Dumne, 2014) before the concrete mixture is applied in the field. The chemicals used are Glenium and Delvo Crete Stabilizer.

Glenium is a chemical added to the mixture in order to make the concrete paste become dilute and easier when applying in the field. The chemical is a superplasticizer that does not alter or affect the ratio of water and cement factor (W/C), although it will provide a poor slump value because the mixture will be dilute. Based on Glenium Material Safety Data Sheet (MSDS), these chemicals contain formaldehyde, methanol, and toluene. The pH of this chemical is about 5.5-8; but more in the acidic state (PT BASF Indonesia, 2011).

Table 7. Concrete pH Test Result

Type of Concrete	pH		
	3 <sup>rd</sup> day	14 <sup>th</sup> day	28 <sup>th</sup> day
$A_0$	12.7	12.14	11.99
$A_1$	12.7	12.26	12.21
$B_1$	12.8	12.28	12.26
$C_1$	12.8	12.27	12.24
$A_2$	12.8	12.27	12.26
$B_2$	12.8	12.22	12.21
$C_2$	12.9	12.24	12.22

Note (s):

- A<sub>0</sub> Concrete : Pure concrete without the addition of acetylene sludge waste
- A<sub>1</sub> Concrete : 5% of sand component substituted by acetylene sludge waste
- B<sub>1</sub> Concrete : 10% of sand component substituted by acetylene sludge waste
- C<sub>1</sub> Concrete : 15% of sand component substituted by acetylene sludge waste
- A<sub>2</sub> Concrete : 5% of cement component substituted by acetylene sludge waste
- B<sub>2</sub> Concrete : 10% of cement component substituted by acetylene sludge waste
- C<sub>2</sub> Concrete : 15% of cement component substituted by acetylene sludge waste

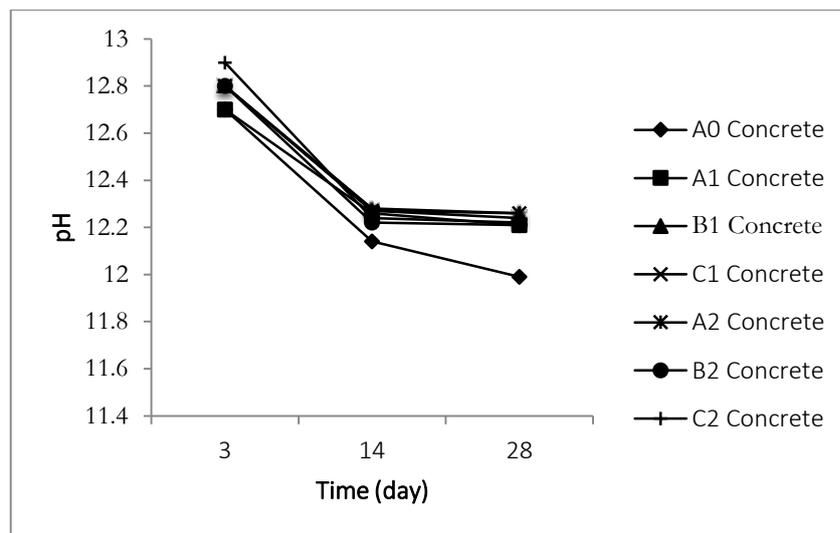


Figure 4. Graph of pH concrete utilization of acetylene sludge waste

Delvo Crete Stabilizer is also a chemical that is added in a concrete mix before application in the field. Only, these chemicals are not always added because their function holds the time setting so that the concrete mixture does not harden quickly. Usually this material is added when the location of its application is far from the batching plant. Based on Delvo Crete Stabilizer Material Safety Data Sheet (MSDS), these chemicals are a mixture of inorganic acid and additives. This material contains phosphonic acid compounds. These chemicals have a very acidic pH of 1-3 (PT BASF Indonesia, 2015).

Both of these chemicals are usually added as much as 1-3 liters per cubic meter of concrete mixture. The addition of these two chemicals is expected to reduce the base value of pH of concrete utilization when applying the concrete mixture in the field (Neville, 1975 in Sutrisno 2009).

## Conclusion

The concrete mixture of acetylene sludge waste utilization gives the slump type 7 with a concrete mixture declined by 16 cm. Based on the compressive strength test results, concrete A1, B1, C1, and B2 give a high strength concrete with C1 concrete having the highest compressive strength of 41.9 MPa. This concrete has a concentration of barium and chromium below the quality standard of 0.019 mg/L for barium and 0.680 mg/L for chromium. The pH of concrete utilization shows a value of 12.24. Thus, it can be concluded that C1 concrete is the best concrete because it can reduce the amount of acetylene waste at most and have a toxicity that is below the quality standard, so it is safe to the environment. The ratio of C<sub>1</sub> concrete mixture as the selected concrete is 23.4 kg of acetylene sludge waste, 7.8 kg of fly ash, 703 kg of cement, 418 kg of sand, 871 kg of gravel and 213 liters of water for 1 m<sup>3</sup> of concrete mixture.

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