



UTILIZATION OF SIDOARJO MUD AS THE RAW MATERIAL OF MAKING PORTLAND CEMENT

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Abstract

Portland cement is generally made of clay, lime, iron sand, silica sand and alumina sand, In this research, the manufacture of cement by using the material in the form of Sidoarjo mud because it has a clay content that resembles that of 2,34% CaO, 6,52% Al₂O₃, SiO₂ Fe₂O₃ 67,63% and 4,88%, making it possible to make an manufacture of Portland cement with addition of CaO and through the combustion process, Research done by mixing mud in Sidoarjo in chalk in some variation ratio of 40:60; 37,5:62,5; 35:65; 32,5:67,5 and 30:70, After a homogeneous mixture and then baked in the furnace at a temperature variation 1200°C with the time allowed is 60, 90, 120, 150 and 180 minutes, Cement is then the compressive strength test and analyzed levels of the chemical, Retrieved best conditions on a comparison between proportion of Sidoarjo mud and lime 30:70, 3 hours burning time and compressive strength value of 13,00 kg / cm² for ages 3 days and 15,08 kg / cm² to age 7 days,

Key word : portland cement, lime stone, Sidoarjo mud,

INTRODUCTION

Mud volcano phenomenon that occurred in the village of Siring, Porong, Sidoarjo regency result of gas drilling wells Banjarpanji Renokenongo-1 in the Village that have occurred since the date of May 29, 2006, is still ongoing, The volume of mud coming out of the bowels of the earth continues to increase annually, from about 5,000 in June 2006 m³/day to 50,000 m³/day by the end of 2006, and continued to increase to 100,000 to 120,000 m³/day in 2007, Until now, still there are signs that the mud will stop (BPLS, 2009), Sludge is composed of various materials, Totok Noerwarsito (2007) from the ITS presented that outlines the characteristics of mud containing clay 71,43%, silt 10,71% and 17,86% sand, Another source of Tekmira (2007) mentions that the main content of the Sidoarjo mud is clay by 40-45%, (BLH East Java Province, 2007), According BPLS (2009), Sidoarjo mud contains almost the same clay used as raw material for portland cement is composed of CaO, Al₂O₃, SiO₂, and Fe₂O₃, The content of CaO in Sidoarjo mud is too small when compared with the required cement content while Al₂O₃, SiO₂, and Fe₂O₃ is sufficient to meet, so that the Sidoarjo mud could potentially be used as materials for portland cement with the addition of limestone, The chemical composition of sludge Sidoarjo is analyzed in comparison to portland cement can be seen in Table 1,

Tabel 1, Sidoarjo mud comparison with the chemical composition of Portland cement

Compound	Compoition	
	Sidoarjo mud	Portland cement
Silikat (SiO ₂)	67,63 %	19 - 25 %
Ferumoxide (Fe ₂ O ₃)	4,88 %	0,3 – 6 %
Aluminium oxide (Al ₂ O ₃)	6,52 %	2 – 8 %
Calcium oxide (CaO)	2,34 %	60 – 65 %

Resources: H, N Banerjea, 1980

Manufacture of cement made by mixing mud in Sidoarjo and limestone and then burn it, thus forming portland cement,

Cement ("caementium" = binder), the definition in general is an adhesive that can bind the solid ingredients into one powerful entity (Rohmawati, H., 2002), Ash or Cement Portland cement is a powder / bulk bluish gray color, made of limestone or limestone and clay or clay, Limestone is the result of mine-containing compounds of calcium oxide (CaO), while the clay contains silica dioxide (SiO₂) and aluminum oxide (Al₂O₃), Both materials are then subjected to melt the combustion process, (Pratomo, A., in Tedifa, 2007), According to George T, Austin (1996), portland cement is defined as the product obtained from the fine grinding clinker consisting primarily of hydraulic calcium silicates and contains one or two forms of

calcium silicate as an additional antargiling, This type of cement based on SNI 15-2049-2004 consists of five types: type I (ordinary portland cement), cement type has high levels of C₂S and C₃A 10% - 15% and a hydraulic cement that is used extensively for general construction does not require any special requirements such as residential buildings, high rise building bridges, runways and highways, Type II (moderate heat cement), having high levels of C₂S and C₃A 6-7%, Cement types are often used for building the waterfront, irrigation and for casting the concrete mass and dams that require resistance to the influence of sulfate and heat of hydration medium, Type III (high early strength cement), has a high content of C₃S and very finely granulated, Cement is used for buildings that require a high initial pressure after casting done

and requires the completion of that as soon as possible, Whiskers for a high-rise buildings, concrete roads, bridges and airports as well as heavy machine foundation, Type IV (low heat cement), Used for low heat of hydration, minerals have a composition of 26% C₂S, 50% C₃S, C₃A 5% and 12% C₄AF, Used for casting and spraying, Type V (sulfate resistance cement), portland cement with high sulfate resistance, including resistance to sulfate salt solution in water, Cement is used for construction of buildings on the land / water containing high sulfate and is perfect for the sewage treatment plant, construction of water, bridges, tunnels, ports and nuclear power plants, Requirements of physics and chemistry of portland cement can be seen in Table 2 and Table 3.

Table 2, Physics requirements of portland cement

Description	Type of cement				
	I	II	III	IV	V
Fineness of the air Permeability test, m ³ /kg with a : turbometer, min	160	160	160	160	160
Blaine, min	280	280	280	280	280
Viscosity :					
Expansion dengan autoclave, max %	0,8	0,8	0,8	0,8	0,8
Compressive strength at 1 days age, kg/cm ² .min	-	-	120	-	-
Compressive strength at 3 days age, kg/cm ² .min	125	100	240	-	80
Compressive strength at 7 days age, kg/cm ² .min	200	175	-	70	150
Compressive strength at 28 days age, kg/cm ² .min	280	-	-	170	210

Resources: SNI 15-2049-2004

Manufacture of cement can be done with 2 (two) ways: first, the wet process, all raw materials are mixed with water 30% - 40%, crushed and vaporized and then burned with fuel, This process is rarely used because of the limitations of energy (fuel), Second, the dry process, the stage of milling and mixing is done dry (moisture content 5%), The clay is dried in advance and mixed materials are then used as bait for the dry combustion stage, The next process with wet process, This study aims to find the burning time and the comparison of proportions between Sidoarjo mud with limestone is best viewed from the value of compressive strength,

METHODOLOGY

Materials and tools,

Materials used in this study is Sidoarjo mud that is still untapped by the community, Sidoarjo mud mud embankments was taken in the area north of the Village Renokenongo center Sidoarjo mudflow,

Tabel 3, Chemical requirements of portland cement

Uraian	Jenis semen portland				
	I	II	III	IV	V
SiO ₂ , min	-	20	-	-	-
Al ₂ O ₃ , max	-	6	-	-	-
Fe ₂ O ₃ , max	-	6	-	6,5	-
MgO, min	6	6	6	6	6
SO ₃ , max					
C ₂ A ≤ 8	3		3,5	2,3	2,3
C ₃ A > 8	3,5		4,5		
Lost incandescent, max	5	3	3	2,5	3
The insoluble, max	3	1,5	1,5	1,5	1,5
C ₂ S, min	-	-	-	35	-
C ₃ S, min	-	-	-	40	-
C ₂ A, max	-	8	15	7	5
C ₄ AF + 2C ₃ A atau C ₄ AF + C ₂ F, max	-	-	-	-	25

Resources: SNI 15-2049-2004

Auxiliary materials used are limestone and aquades from store chemicals in Surabaya, While the tools used in this study is 1200°C temperature furnaces, ovens, digital scales, mortar, sieve 200 mesh and compressive strength test equipment, The treatments set is the temperature of combustion: 1200°C, The treatments run the comparison of proportions between Sidoarjo mud with limestone (wt%): (40:60), (37,5:62,5) (35:65), (32,5:67,5); (30:70) and burning time (minutes): 60; 90; 120; 150; 180,

Research Procedure

Preparation

Limestone crushed and then sieved with 200 mesh size and Sidoarjo mud dried in an oven at a temperature of 100°C to constant weight, crushed and then sieved with 200 mesh size to match the size,

Cement manufacture

Sidoarjo mud limestone and mixed until homogeneous with various proportions according to the prescribed treatment,Subsequently burned in the furnace at a temperature of 1200oC and appropriate treatment time, Then cooled and sieved with 200 mesh size,

Compressive strength test

Cement printed cylindrical with a diameter = 3,5 cm and height = 7 cm with a ratio of cement mortar

composition was made permanent,ie ratio of cement: sand = 1: 3 (volume ratio),Subsequently analyzed compressive strength with age 3 and 7 days,

RESULTS AND DISCUSSION

Cement mixed with sand that has formed and the water then printed cylindrical with a diameter of 3,5 cm and height 7 cm,After the age of 3 days and 7 days were tested strongly compressed

Table4, Test results of compressive strength of cement at the age of 3 days

Proportion of Sidoarjo mud : batukapur	Kuattekan(Kg/cm ²)				
	w	w	wa	w	w
	aktu 1 jam	aktu 1,5 jam	ktu 2 jam	aktu 2,5 jam	aktu 3 jam
40 : 60	4,37	5,30	6,45	7,28	7,38
37,5 : 62,5	5,10	6,24	6,86	7,70	7,90
35 : 65	5,82	7,18	7,59	8,11	8,32
32,5 : 67,5	6,45	7,80	8,32	8,84	9,15
30 : 70	7,49	9,36	10,61	11,54	13,00

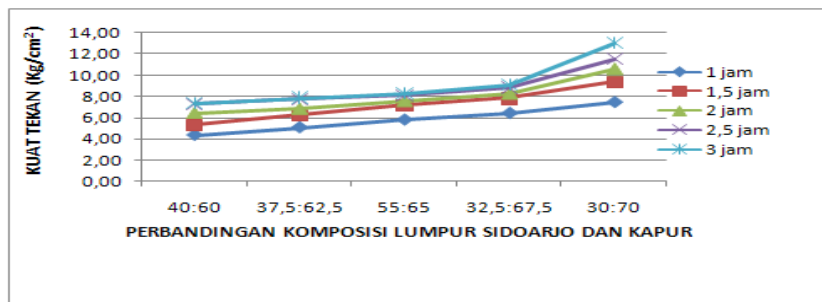


Figure 1, The relationship between the proportion of Sidoarjo mud and limestone with a compressive strength (age 3 days)

Table5, Compressive strength test results at age 7 days

Proporsilumpur Sidoarjo : limestone	Compressive strength(Kg/cm ²)				
	Ti me : 1 hour	Ti me : 1,5 hour	Ti me : 2 hour	Ti me : 2,5 hour	Ti me : 3 hour
40 : 60	5,51	6,76	7,28	7,59	8,32
37,5 : 62,5	6,45	7,28	7,90	8,32	8,63
35 : 65	7,18	8,01	8,63	9,36	9,57
32,5 : 67,5	8,32	8,63	9,57	10,09	10,40
30 : 70	10,42	11,23	12,48	14,14	15,08

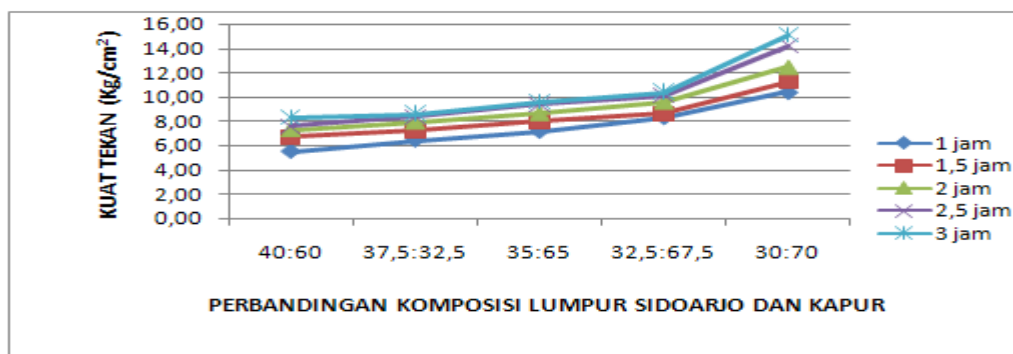


Figure2, The relationship between the proportion of Sidoarjo mud and limestone with a compressive strength (age 7 days) 3

compressive strength test results obtained the largest value found in the comparison of proportions of cement and lime mud in Sidoarjo 30:70 with 3 hours of burning time for ages 3 13,00 kg/cm² 15,08 kg/cm² for the day and 7 days old. Furthermore, to improve the content of C₃S, C₂S, C₃A, and C₄AF contained in cement performed chemical analysis followed by calculation in accordance with the formula contained in the SNI 15-2049-2004, Table 6, Results of analysis of the chemical composition of cement in the proportion 30:70 Sidoarjo mud and the burning time of 3 hours,

Test Parameters	Test result
Silikat (SiO ₂)	18,18
Besioksida (Fe ₂ O ₃)	0,89
Aluminiumoksida (Al ₂ O ₃)	0,3651
Kalsiumoksida (CaO)	40,96

Table 7, Comparison of compressive strength test results with the largest SNI

Umur (hari)	Hasil uji kuat tekan (kg/cm ²)	SNI 15-2049-2004				
		Tipe I	Tipe II	Tipe III	Tipe IV	Tipe V
3	13	125	100	240	-	80
7	15,08	200	175	-	70	150

Resources: SNI 15-2049-2004

Furthermore, to improve the content of C₃S, C₂S, C₃A, and C₄AF contained in cement performed chemical analysis followed by calculation in accordance with the formula contained in the SNI 15-2049-2004,

Table 8, Results of analysis of the chemical composition of cement from the Sidoarjo mud with a ratio of the proportion of 30:70 with burning time 3 hours

Uraian	Hasil analisa	SNI 15-2049-2004				
		Tipe I	Tipe II	Tipe III	Tipe IV	Tipe V
SiO ₂ , MIN	18,18	-	20	-	-	-
Al ₂ O ₃ , MAX	0,3651	-	6	-	-	-
Fe ₂ O ₃ , MAX	0,89	-	6	-	6,5	-
C ₃ S, MIN	24,85	-	-	-	35	-
C ₂ S, MIN	33,37	-	-	-	40	-
C ₃ A, MAX	0,538	-	8	15	7	5
C ₄ AF + 2C ₃ A, MAX	52,41	-	-	-	-	25

Resources: SNI 15-2049-2004

Figure 1 and Figure 2 shows that the compressive strength gained more in line with the rising proportion of mud in Sidoarjo: limestone, This is caused by the increase in CaO, where CaO is a chemical that has a function as an adhesive / binder (Wiryasa and Sudarsana, 2009), With increasing CaO content of the adhesion of cement also increased so that the compressive strength obtained is also getting bigger, in Figure 1 and Figure 2 also shows that the greatest compressive strength shown on the longest burning time is 3 hours, This is caused by the increased burning time then the compounds are very influential on the compressive strength of cement such as C₃S, C₂S, C₃A and more formed when compared with that found in semen that burned with a shorter time, (Lea, FM, 1970) , In the picture also looks pretty extreme increase occurred in comparison 30: 70 because the ratio is already close comparison of the actual cement raw materials with 20% clay and 80% lime (Windi and Dody, 2009), The results of calculations obtained C₃S is positive indicating that in these compounds C₃S cement is formed, This happens because the new C₃S began to form at temperatures 1200oC and fully formed at temperatures above 1260oC to 1450oC, C₂S showed significant positive value since the C₂S 1200oC temperature maximum has been formed, C₃A showed positive values due to the temperature 1200oC most of C₃A was formed, C₄AF showed a positive value because the majority of C₄AF 1200oC temperatures have started to form, (Lea, F.M, 1970), Table 7, shows that the compressive strength values obtained are very small when compared with the standard contained in the SNI 15-2049-2004, This can occur because of C₃S are very influential on the compressive strength has not been fully formed and the content of CaO that serves as an adhesive substance is also not meet the standard for portland cement,

CONCLUSION

The best condition that produce the greatest value of the compressive strength of 13 kg/cm² for 3 days and 15,08 kg/cm² for the age of 7 days is obtained on the proportion between Sidoarjo mud and lime STONE 30:70 with a burning time of 3 hours, Compressive strength values obtained by comparison with SNI 15-2049-2004 ranging from type I to type V are not yet qualified because of C₃S are very influential on the compressive strength has not been fully formed and the content of CaO that serves as an adhesive substance is also not meet the standard for portland cement,

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