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Preface

The objective of the 1st International Conference of Rehabilitation and Maintenance in Civil Engineering (ICRMCE) is to provide the forum and to initiate a network for the engineers, academicians, government agencies and practitioners in exchanging the ideas and experiences, technological advancement and innovation related to rehabilitation and maintenance in civil engineering.

This event has been responded positively by the engineers, academicians, governments agency and practitioners. Since its first announcement on last September 2008, the organizing committee has received 92 abstracts from nine countries and finally 66 full papers could be presented in this conference proceeding.

The topics of papers are divided into fifteen groups of sub-theme. Those are (a) Special experiences on building and infrastructure rehabilitation and maintenance, (b) Advanced Technology on Building and Infrastructure Rehabilitation Technique, (c). Assessment of Building and Infrastructure Performance, (d) Assessment of Building and Infrastructure Performance Related to Natural Hazard, (e) Smart Material for Building and Infrastructures Repair (Including Material Development for Building and Infrastructures), (f) Building and Infrastructure Damage Assessment, (g) Building and Infrastructure Maintenance Strategy, (h) Testing and Inspection, (i) Restoration, Preservation, Rehabilitation and Maintenance of Historic Building, (j). Management on Building and Infrastructure Maintenance, (k) Building and Infrastructure Service Life Modeling, (n) Code on building and infrastructure rehabilitation and maintenance (o) Others.

This event is organized by the Department of Civil Engineering of Sebelas Maret University (UNS-Solo), School of Rehabilitation and Maintenance in Infrastructure of Post Graduate Program of Civil Engineering, Sebelas Maret University (UNS-Solo) and the Ministry of Public Works of Republic Indonesia with the supporting partner Karlsruhe Institute of Technology (KIT), Indonesian Society for Building Maintenance (HAPBI) and University of Chulalongkorn.

On behalf of the organizing committee I would like to thank the institution partners, the speakers and the paper contributors, the sponsors, the media partners, all the committee members, the Civil Engineering Service (CES) and the Association of Civil Engineering Students (HMS) of Sebelas Maret University (UNS-Solo) for their great support.

Solo, 21st March 2009.

Dr. Sholihin As'ad

Chairman of the Organizing Committee of

1st International Conference on Rehabilitation and Maintenance in Civil Engineering (ICRMCE)

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BEACH SAND in MORTAR

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Abstract

This paper discusses about compressing strength mortar containing coastal sand and river sand, with pozzolan portland cement (PPC) and portland cement (PC). The sand took at the beach of: TelengRia and Lorok at Pacitan, Popoh and Bandung at Tulungagung, Ngliyep, Balekambang, and Sendang Biru at Malang, Puger and Watuulo at Jember, Grajagan and Sukamade at Banyuwangi. Sand observation and test were done at laboratory of UMM. The specimens were cubical of $5 \times 5 \times 5 \text{ cm}^3$. Mix design of mortar were 1 Portland Cement : 3 Fine Aggregate (sand of the beach-SB of 0, 20, 40, 60, 80, 100% combined by river sand-RS of 100, 80, 60, 40, 20, 0%), there were two kind of cement Portland and Pozzolan Portland on that mixture, and the cement water ratio was 0,465. The result showed that finess modulus of beach sand was 2.34-3.52. The specific gravity of fine aggregates of Puger beach was the greates of $2,873 \text{ gram/cm}^3$ and the lowest was Sukamade beach sand of $2,314 \text{ gram/cm}^3$, and Brantas rivers and was 2.57 gram/cm^3 . The clay lump of Puger beach sand, Sukamade beach sand, Brantas river sand was 0.74; 0.76; and 0.68 respectively. The compressive strength on 14 days test of control mortar of 1 PC : 3 river sand was 1.7% lower than mortar containing 20% of beach sand and 80% of river sand. The compressive strength of mortar 40% beach's sand: 60% river sand and mortar with pure beach sand were 91% and 17% of the control. 28 days test showed that compressive strength of mortar at age of 28 days of 1 PC : 3 of pure beach fine aggregates; 1PC:40% of beach sand and 60% river sand; 1PC:20% of beach sand and 80% river sand, were 16%, 75%, and 82% of compressive strength of normal mortar.

Key words: beach sand, compressive strength, mortar, river sand

1. INTRODUCTION

The publications of this article is to give information to public about the possibilities usage of beach sand as building materials, such as mortar. The beach sand as replacement of river sand in mortar. Further more, the usage of natural resources that conducted by the researcher or others for improving the prosperity of the societies (Suhendro, B., 2003). This article is not reveal yet about the profit and loss of beach sand, but just the first step to take the advantages of coastal resources for building material. In other word, this research may needed as a new breakthrough in the world of civil engineering that is still required (Besari, M.S., 2007).

Sand as a building material is needed. The demand for people to have a place for living is high enough; the growth of the total population is greater than the houses built. There were houses and other building near to the beach. The observation along the north coast of East Java's at Rembang up to Muncar reported that sand near to the beach could be use as building material, for instance mortar, concrete, plasteran on building houses, warehouses, or other buildings (Husaini and M. Dwi, MR, 2004; Wahyudi, Y., 2006).

The mining of sand from the river basin (in example: Konto, Brantas, Bengawan Solo), or at the mountains of Merapi or Semeru, or from the open land. It was done to meet the public demand. Mining activities without

wise consideration may cause unstable condition. The losses such as the natural balance disrupted, landslides, and less stability of civilians along the river can be directly, or in the future. Humans and the environment are in a state of balance, they are called in healthy condition. When the stable condition may not be achieved, it can cause harmful effects for the health, or the other (Eddie, W.S., 2006). Processing of natural resources that pay the balance of the environment is needed to improve the welfare of the people. Inquiries are needed for new materials that function as filler like sand, or new resources, for example near to the beach.

Specy or mortar was laid between red bricks at wall working in door or out door, plaster layer, or the other. It contains cement, sand, and water. The proportion of mixture depends on the function of mortar. The more cement contain the higher compressive strength. At the first time, fresh mortar looks like slurry, but in a certain time the mixture getting harder like rock (Murdock, 1980). Mortar can be made by adding additives or without additives. The function of additives material is accelerating the reaction between cement and water (Tjokrodimaljo, 1996).

The characteristics good mortar is cheap, strong or durable, higher workability (stirred, lifted, installed, and trim), with a good tape between bricks, stones, and so forth, fast dry or hard, face-resistant seepage water, and no surface cracked found (Trimulyono, 2004). The aggregate shall be free of injurious amounts of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a color darker than the standard shall be rejected (anonymous, 2008).

Cement is produced by burning sublime klinker that consists mainly of calcium silicate and gypsum as an additional material (PUBI-1982). Cement paste as an adhesive material, aggregate fill space between the aggregate to become a compact mass or solid. Cement elements, namely: disilicate calcium, trisilicate calcium, trialuminate calcium, and tetra aluminoferrite calcium react with water

to be silicate hydrate calcium which is hard (Neville, 1981)

The reaction of cement and water to form a calcium silicate hydrate that hard performance. There are two sections on the hardening cement processing, namely the initial time, and setting time. Initial time is the time that needed on mixing cement and water until plastic nature will be lost. Setting time is the final time of the fresh cement paste change or set into a hard mass (Tjokrodimaljo, K., 1996).

The specific gravity of cement in the range of 3.10 to 3.30. The type of weight on average used 3.15, and the volume weight of it depends on the laboratory processed (Wuryati, S. and Candra, R., 2001).

Portland Cement (PC) for common use does not require any special requirements, and Pozzolan Portland Cement (PPC) works to generate less heat hydrations on cement paste, and dirt resistance. PPC used for irrigation building, or building with mass concrete (Tjokrodimaljo, 1996). The usage of pozzolan in mortar or concrete reduces the strength, because of pozzolan increases water cement ratio (Colleparadi, M. et. al., 1994). On the other hand, concrete containing pozzolan and superplasticizer able to improve its quality, shorter setting time, higher compression strength before the age of 28 days, more flexible, greater splitting (tensile strength), lower elasticity modulus, smaller shrinkage cracked, compared with the concrete containing silica fume (Zhang, M.H. and Malhotra, V.M., 1995).

Table 1. Specification of physically testing on portland cement

Item Test	SNI 15-0302-94		ASTMC595-00a	
	PC	PPC	PC	PPC
Finess : - blaine equipment (m ² /Kg)	>280	>280	>280	-
Vicat test - Initial time (minute)	> 45	> 45	> 45	> 45
- Time set (minute)	<375	<420	<370	<420
Autoclave test - Increase (%)	< 0.8	< 0.5	< 0.8	< 0.8
- Decrease (%)	-	< 0.2	-	< 0.2

Compressive Strength:				
- 3 days (Kg/cm ²)	>125	>125	>122	>133
- 7 days (Kg/cm ²)	>200	>200	>194	>204
- 28 days (Kg/cm ²)	-	>250	-	>255
False set				
- penetration (%)	>50	-	>50	-
Hidration Calory				
- 7 days (cal/gr)	-	< 70	-	< 70
- 28 days (cal/gr)	-	< 80	-	< 80

PC :Portland Cement, Semen Portland

PPC:Pozzolan Portland Cement, Semen Portland Pozzolan

Source: Wuryati, S. and Candra, R. (2001)

Aggregate was classified into coarse aggregate in diameter more than 40 mm, middle aggregate diameter between 5 mm to 40 mm, and fine aggregate in diameter of 0.15 mm and 5 mm. Well aggregate has a rounded shape or cube, clean, high stiffness, strong, and heterogeneous grains, chemical stable order, and in certain matter should be weatherproof (Murdock, L.J., 1980).

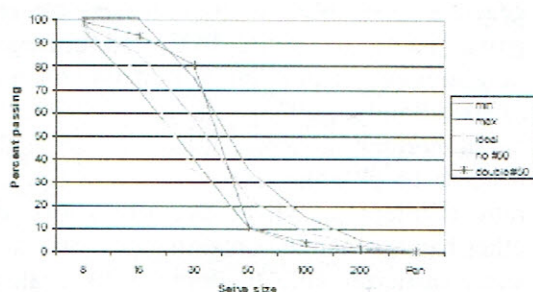


Figure 1. A series of sand gradation curves for an ASTM C 144 material showing maximum, minimum, ideal, and #50 modified sands (Anonymous, September 10 2008)

Aggregate derived from natural resources, which have experienced natural diminution size (such as gravel), or a split with the natural stone, or dig the land, or mine in the bottom of the river, or from the waterfront. Sand cut, obtained directly from the surface or dig the way first. Sand extractive usually sharp, cornered, porous and free from the womb of salt, but usually must be clean of dirt to be washed with the land. Sand of river that grain is smaller and round shape, the effects of friction. Beach sand made from the friction or rock in the sea. It has smaller diameter than rivers sand, rounded shape because of friction, and saline. The binding salt water from the sea so that the sand a bit wet. The volume

of mortar containing beach sand greater than normally mortar (Tjokrodinuljo, K, 1996).

The factors of sediment (deposit such as aggregate) related to the geological history that surrounding area. Geological processes that formed the deposit, or modifications to the sequence, such as size, shape, location, type, condition of the rock, and gradation, determination, and infirmity. The strength of grain or food to the friction effect or impact on the strength of cement paste. Porosity and the water absorption affect the resistance against the grain aggregate; freezing in the winter time, and chemical solvents aggression, and the resilience of the depreciation (LJ Murdock, 1980).

Fine aggregate pass sieves of diameter 0.15 mm - 4.80 mm. British Standard (BS 1881) states that the aggregate fine grain distribution is divided into four zones, such as zone of 4 a tiny, very small or subtle grains; zone of 3 for a bit fine aggregate, zone of 2 for median grain, and the right area, zone of 1 for coarse sand. Mortar containing uniform aggregate provides pores. Conversely, varies gradation increase the pore volume, because the tiny grain filling the small pore, so that the mass becomes solid. In other words high mass congestion. Fine aggregate as filler materials reduce shrinkage, which is quite hard grain and gradation that vary speci that the influence of weather-resistant (Supribadi, 1986).

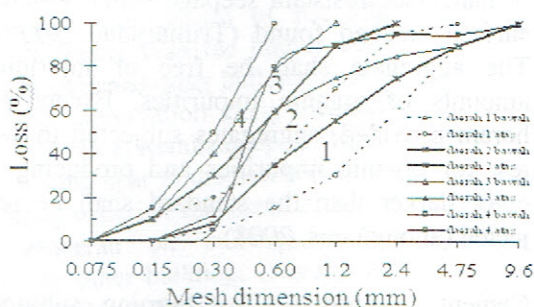


Figure 2. Zone gradation of aggregate (PUBI 1982)

Fine aggregate in accordance with PBI 1971 (Indonesian Concrete Standard, 1971) and PUBI 1982 (Indonesia Building Materials Standard, 1982) article 3.3 of the sand rock, consisting of grain and a hard edge, the may not contain more than 50% (determined to

dry weight), when the rate exceeds 5% mud and must be washed, may not contain organic material, consisting of grains size of the diverse, sand of beach may not be used as aggregate fine except with the instructions from the institution review materials approved.

2. METHOD

Amount of sand has taken at south coast of East Java, approximately 10 m from the seawater at low tide. The sand has gotten into the plastic bags. The weight of bag was 15 kg to 17 kg.

Those beach are Telengria and Lorok at Pacitan, Bandung and Popoh beach at Tulungagung, Ngliyep, Balekambang, and Sendangbiru beach at Malang, Puger and Watuulo beach at Jember, Grajagan and Sukamade beach at Banyuwangi.

Gradation test on beach sand and river sand based on SK-SNI-T-15-1990-13. The test on beach sand was done without washing into the fresh water; similarly to the mixture of mortar that used at houses near to the beach. The characteristic or behavior of mortar containing beach sand at building near to the beach could not be described perfectly yet. Examination conducted as: 1) grain analysis, 2) volume weight, 3) density, 4) water absorption. The value shown from an average of three times the test.

The proportion of material was 1 cement: 3 sand, and the water cement ratio was 0.65. Two kinds of cement type were comparing in compression strength of mortar. The type of cement were Portland Cement (PC) and Pozzolan Portland Cement (PPC), they marked as Semen Gresik. The percentage of beach sand as replacement material on Brantas river sand be risen. The proportion of sand were: 1) 100% beach sand (Bs) and 0% river sand (Rs), 2) 80% Bs and 20% Rs, 3) 60% Bs and 40% Rs, 4) 50% Bs and 50% Rs, 5) 40% Bs and 60% Rs, 6) 20% Bs and 80% Rs, and 7) 0% Bs and 100% Rs. There were 14 types of mortar mix with sand beach womb certain areas, the overall number of $11 \times 14 = 154$ types of mortar mix. Tests conducted on material observation and the compression strength on cubical mortar specimens aged of

14 days and 28 days. The total type of mortar $154 \times 2 = 308$, each consisting of 10 cubes.

The mixing machine mixed those materials homogeny. The first stage, of mixing was dry mixing, then followed by water added, till homogeneous fresh mortar in the final stage. The weight of 5 kg mortar were portland cement of 1.991 kg PC type or PPC type, 3.009 kg of sand beach (for 100% Bs: 0% Rs), and 0.925 kg of water. The mixture of portland cement type PC: 80% of Bs: 20% of Rs = 2047 kg: 2.3624 kg: 0.5906 kg. Then for PPC type : 80% of Bs : 20% of Rs = 2045 kg: 2364 kg: 0591 kg. The proportion of normaly mortar without Bs was PC: 100% of Rs = 1986 kg: 3014 kg; and PPC cement of 2.002kg: 2.998kg of Rs.

The fresh mortar was casted into cubical steel molds of $5 \times 5 \times 5 \text{ cm}^3$ for 24 hours. After that, the cubical mortar removed from the mold. Then they were cure in water during 28 days, regardless of the acidity of water. Drying processed on specimens were done for 24 hours before the compression strength test. The specimens were test at age of 14 days and 28 days. Then compare to each other.

3. RESULTS AND DISCUSSION

The report test on portland cement Semen Gresik brands were: specific gravity of was 3.15, grain refinement tested was 90.8%, consistency test of 24.5%, and initial time on vicat test was 135 minutes and 170 minutes for setting time. The test and the result in accordance with the standard of SNI 15-0302-94, and ASTM C 595-00a. The result showed that the portland cement in good condition and can be used in the mortar mix.

The specific gravity of PPC cement was 3.153; the fineness of cement grain was 92.74%, consistency normal of 26%, and the initial time of 150 minutes and the setting time of 210 minutes. The nature of the physical examination showed that the PPC cement used in good condition and is eligible to use in the mortar mix. The report of vicat test showed that the initial and setting time of cement PPC longer than the cement PC.

Observations in the field showed the number of quite a lot of sand, the beach of Popoh for example, approximately 400 m far from the sea at low tide to the mainland, along the coast, and 2 m in depth may also be more grain of sand; Pacitan Beach, approximately 200 m from the sea at low tide to the mainland along the coast and the depth of 2 m; in coastal Grajagan Banyuwangi wide sandy area that is less than 200 m, to reach the beach lips must pass the hill which is quite high and approximately 10 km from kecamatan office.

The surface observation showed that grains of beach sand were smaller than river sand; river sand sharper than beach sand. Properly aggregate fine grain roughness can be measured as grain roughness of glass marbles expressed in cycles / minute drum in Los Angeles machine (Nurwidayati, R. in Besari M.S., 2007).

3.1. Sieve analysis

The gradation test result showed that the beach sand was fine aggregate, diameter of 0.075 mm to 1.2 mm. The percentage of grain in sieve of 50 (diameter of 0.3 mm) was the largest percentage of the captive grain sieve number. The number of unloss sand on sieve of 50 were sand of Telengria 48.72%; Lorok 49.72%; Popoh 50.4%, Bandung 56.33%; Ngliyep 77.69 %; Balekambang 56.1%; Sendangbiru 61.95%; Puger 65.12%; Watuulo 67.87%, Grajagan, 74.55% and 90.38% Sukamade.

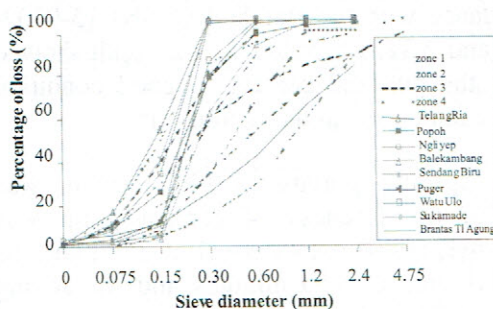


Figure 3. The gradation of beach sand

Gradation analysis on beach sand and river sand based on SK-SNI-T-15-1990-13, the results showed that beach sand has lost in diameter mesh of 4.80 mm. The Fine modulus (FM) sand of Telengria beach of 2.34, and

Lorok beach was 2.51; Sendangbiru beach was 2.55; Watuulo 2.63; Grajagan and Sukamade were 2.92; Popoh beach 3.04; Bandung beach was 3.1; Ngliyep beach was 3.12; Puger beach was 3.13; Grajagan beach 3.47; Balekambang beach was 3.52. And the FM of Brantas river sand which pick up at Tulungagung was 4.8. The finess modulus of sand near to the beach was smaller than the river sand of Brantas. The grain of beach sand may has greater abrasion than river sand. Abrasion caused by sea wave.

3.2. Clay lumps

The pattern image on Fig. 4 below shows that the highest average of clay lumps of 3.41%, and the lowest was 0.66%. It means that sand beach of the west side of east java province may have an inorganic dirt more than east side. However, there were others factors influence mud content, such as sand of open beach different from the bay beach. Sand of beach at east side was relatively lower mud content, it took at Sukamade, a nature beach without recreation place. Meanwhile, the mud content of Brantas river sand that took at Tulungagung was 1.43. The building material standar of Indonesia or Peraturan Umum Bahan Bangunan Indonesia (PUBI) 1982 article 3.3 paragraph 3 told that sand contain mud level smaller than 5% has no need washing.

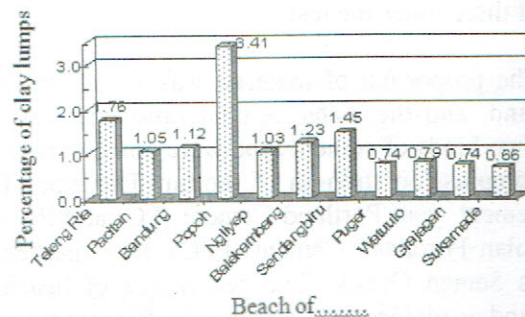


Figure 4. The average of percentage of clay lumps

The sands has pick at about 50 m from low tide seawater level. The result showed that sand beach of Popoh contains the highest seawage. Since the location was the tourist area that many people there on Saturday or Sunday. Dust or dirt likely came from the relative mobility of visitors more than the working day.

The average clay lumps of sand taken from Sukamade sandy beach was 80% lower than sand of Popoh. Sukamade sandy beach rarely visited by tourists. The beach is a hilly forest, where the road quite remote town of 58 km south of Banyuwangi, and be relatively difficult. Similarly where the sand beach of low clay lumps in beach of Grajagan at Banyuwangi, beach of Bandung at Tulungagung, beach of Balekambang at south of Malang, and beach Puger, Watuulo at Jember.

3.3. Specific gravity

Figure 5 shows that the average specific gravity of sand beach at south of East Java were almost the same. The biggest specific gravity was 2.873 gr/cm^3 , it took at beach of Puger. The specific gravity of Puger fine aggregate was greater 0.223 or 8% than the sand of river Brantas at section of Tulungagung (2.57 gr/cm^3). The lowest specific gravity was fine aggregate of Sukamade beach.

The specific gravity of sand beach of Grajagan and Sukamade were 2.425 gr/cm^3 and 2.314 gr/cm^3 . Those were not include normal fine aggregate, because the specific gravity of normal fine aggregate between 2.5 - 2.7 gr/cm^3 (Tjokrodinulyo, 1996).

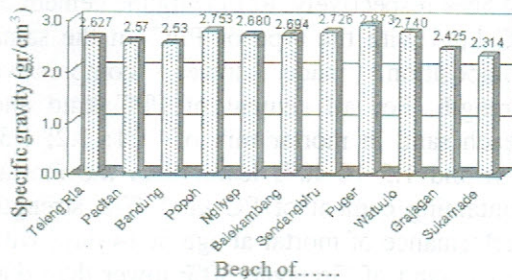


Figure 5. Specific gravity of fine aggregate of the beach

The highest specific gravity of sand beach was 2.87 gr/cm^3 which came from Puger beach at Jember. The difference of that may caused the proportion of deposit material that did not reported. The specific gravity of Brantas river sand at section of Tulungagung was 2.65 gr/cm^3 .

3.4. Water absorption

The water absorption of sand beach south of East Java is shown in the Fig. 5 below. The

water absorption of Bandung sand beach at Tulungagung was the highest, it was 3.87%. The smallest one was 0.95% for beach sand Watuulo. Absorption water of Brantas river sand was 2.89%. The value of water absorption sand beach south west of the East Java (at Pacitan regency) was greater than the east side (at Banyuwangi regency). The curve of Fig. 4. has the same trend like Fig. 5.

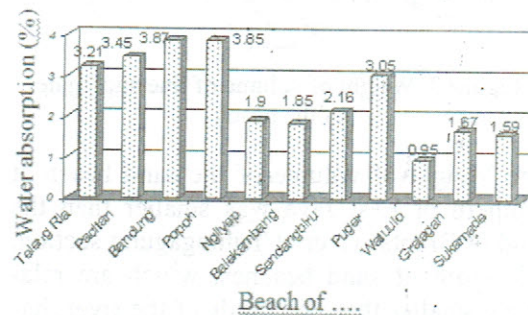


Figure 6. Water absorption of beach fine aggregate

When the mass of sand grain consist of the same material, the greater water absorption sand the smaller specific gravity (Wahyudi, Y. 2000). Higher dense grain shows a little water absorb relatively. Unfortunately, limitations in the study, so that has not been able to reveal more detail.

3.5. Weight of volume

Histogram of average weight of volume displayed in the figure below, but that is only the average value of the weight of volume without penetration. Weight of volume with penetration and vibration to be done and the average value of figured almost the same. Weight of volume of the sand southern beach of East Java at west side was smaller than the east. The highest average value was Puger beach sand of 1.8 ton/m^3 , and the lowest one was 1.29 ton/m^3 for Pacitan beach sand. Weight of volume was 5% smaller than of the one on vibration table.

The test on Brantas river sand in section of Tulungagung showed the average weight of volume of 1.7 ton/m^3 ; the average weight of volume in penetration of 1.7912 ton/m^3 ; the average weight of volume with vibration of 1.8077 ton/m^3 . Weight of volume of river sand was 1.7739 ton/m^3 .

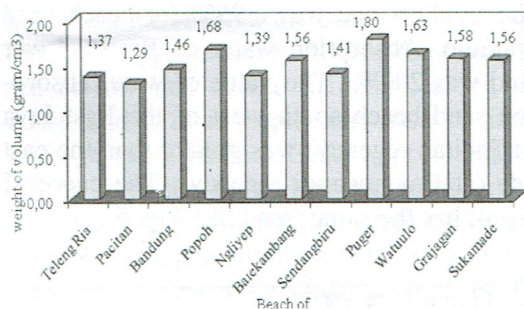


Figure 7. Weight of volume of fine aggregate of the beach

The Weight of volume of the sand beach at southern of East Java was smaller than the sand of Brantas river at Tulungagung section. The grain of sand beaches, which are relatively smaller than the sands of the river, has a more serious light than the river sand. Therefore, it seems more grain of river sand more compact than the beach sand.

3.6. Mortar consistency

Mortar consistency test results shows in Table 2. indicates that the value of D after vibrating greater than the before of D'. Each type of mortar mix containing PC has a value of D smaller than the mortar containing PPC. This pattern was also followed by the value of D'. The mortar consistency containing PC or PPC has the same percentage. Therefore, consistency stirs when wet sand beach on the actual test is the same as the nature of the river sand.

Table 2. Mortar Consistency on mix design of 1PC : 3sand

Cement type	BS %	RS %	D (mm)	D' (mm)	a=D/Dx100%
PC	100	0	113,5	112,9	100,53
PPC			113,6	113	100,53
PC	80	20	114,6	114	100,53
PPC			114,8	114,2	100,53
PC	60	40	114,3	113,7	100,53
PPC			114,5	113,9	100,53
PC	50	50	114,2	113,5	100,62
PPC			114,4	113,8	100,53
PC	40	60	114	113,4	100,53
PPC			114,2	113,6	100,53
PC	20	80	113,7	113,1	100,53
PPC			113,9	113,3	100,53

PC	0	100	114,7	114,1	100,53
PPC			114,9	114,3	100,52

Note: Bs= beach sand

Rs= river sand

D = diameter after vibrating

D' = diameter before vibrating

3.7. Compression strength

The results of various mix mortar containing cement and beach sand (Bs) of Grajagan and Sendangbiru, at the age of 14 and 28 days showed in the curve below:

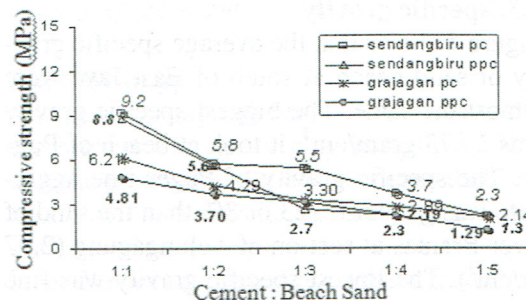


Figure 8. Compressive strength at age of 14 days

Compressive strength mortar at age of 14 days, with a mixture of 1 cement of PC: 1 beach sand of Sendangbiru was 9.2 MPa; increasing the amount of sand in the mortar mixture into 2, 3, 4, and 5 time will reduce the strength of 63.16%, 59.64%, 40.35% and 24.56% respectively. Replacing the cement of PC kind with the type of PPC on the same composition made lower compressive strength. For all cement of PPC kind and beach sand in mortar mix of 1:1; 1:2; 1:3; 1:4; and 1:5 10-40% lower than the mortar containing cement of PC kind. The strength performance of mortar at age of 14 days with beach sand of Grajagan 30% lower than that containing sand of Sendangbiru beach. The compressive strength of mortar was 35%, 26%, 40, 25% and 7% in the mix of PC cement and beach sand of 1:1; 1:2; 1:3; 1:4; and 1:5 respectively.

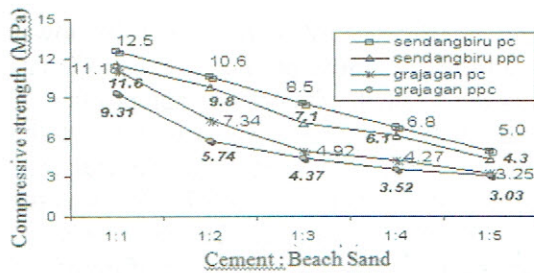


Figure 9. Compression Strength at age of 28 days

The compression strength of mortar at age of 28 days on 1 cement PC: 1 Bs of Sendangbiru was 12.5 MPa; increasing the amount of sand in the mortar mixture into 2, 3, 4 and 5 will reduce the strength performance to be 84%, 68%, 54% , and 40% of the control. Compression strength mortar at age of 28 days containing 1 PC cement : 1 Bs of Sendangbiru. Replace the PC with the type of cement mortar with the PPC on the composition of the same strong press a smaller average of 11%. Strength of mortar sand beach Grajagan average decreased by 31% of the mortar with sand beach Sendangbiru.

The strength performance of cement in the type of PPC containing sand of beach aged 14 and 28 days were lower than the cement PC. The compression strength of PPC mortar cement was lower than the PC at the age of 14 and 28 days, it increased above the age of 28 days (SNI 15-0302-94 and ASTM C 595-00a).

Number of cement mortar mix in determining the performance of mortar. PC type of cement has better performance than the PPC. PPC that contain more pozzolan cement cannot improve the compressive strength of mortar containing sand of beach at the age of 28 days. That statement is consistent with Collepardi, M., S. Monosi, P. Piccioli, (1994) and Tjokrodinuljo (1996).

The curve pattern of compression strength of mortar at age of 14 days with different composition of cement and sand decreased in accordance with the increase for sand; this pattern is not much different from the compression strength at the age of 28 days. Based on it, the compression strength test for mortar containing beach sand performed at the age of 28 days.

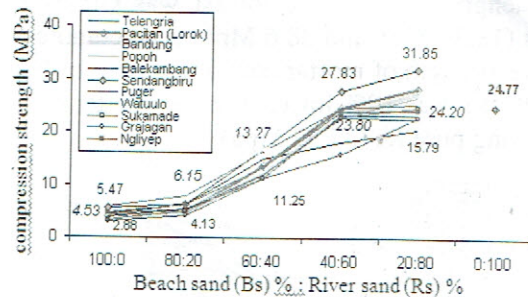


Figure 10. The compression strength of mortar of 1PC: 3 Sand at age of 14 days

The highest compression strength of mortar at age of 14 days containing beach sand of Sendangbiru was of 5.47 MPa. Then mortar containing beach sand of Puger, Pacitan (Lorok), Bandung, Popoh, Sukamade, Telengria, and Grajagan. The lowest compression strength of mortar was 2.88 Mpa, it contain sand beach of Grajagan.

The compression of mortar on composition of beach sand and river sand of 40%: 60% and 60%: 40% were 24.77 MPa. That strength performance as strong as river sand mortar (control). The compression of mortar containing beach sand of Puger, Sendangbiru, Popoh, Bandung, Pacitan (Lorok) 5% higher than control.

The compression strength of mortar in mix design of 1 portland cement: 3 sand, the sand composition was beach sand and river sand with a opposite percentage. The percentage of beach sand moving down from 100 to 0, the river sand from 0 up to 100.

The curve trend at figure 11 has the same trend with the previous image. The lowest compressive strength of mortar containing beach sand at age of 28 days was the mix design of 1PC: 100% Bs: 0% Rs, it was 4.92MPa. Then it has increased of 30%, 60%, 30% and 5% on sand composition of Bs: Rs 80%: 20%; 60%: 40%, 40%: 60%, and 20%: 80% respectively. At the horizontal axis of 40:60 and 20:80 show the optimal compressive strength. The highest compressive strength was the mix design of Puger Bs (34.7 MPa and 34.62 MPa), Balekambang Bs, Sendangbiru Bs, Pacitan (Lorok) Bs,

Bandung Bs, Popoh Bs, Sukamade Bs, Telengria Bs, and the lowest was Grajagan Bs (18.24 MPa and 28.6 MPa). The compressive strength of mortar containing 20% of Bs: 80% Rs was 10% lower than the mortar containing pure Rs (37.32 MPa).

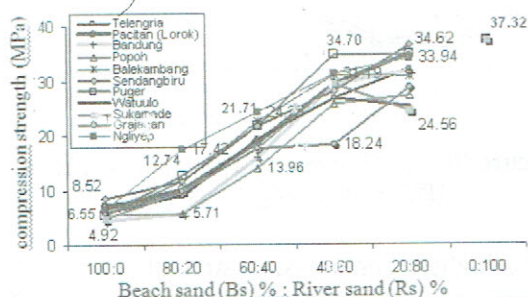


Figure 11. The compression strength of mortar of 1PC: 3 Sand at age of 28 days

Kuat tekan mortar berpasir pantai tertinggi yakni dari pasir pantai Sendangbiru sebesar 8,52 MPa, sedangkan yang terendah yaitu mortar berpasir pantai Sukamade 4,92 MPa. Mortar pp Puger memiliki kekuatan tertinggi pada kolom komposisi pp:ps. dan Grajagan.

The highest compression strength mortar containing beach sand beach was 8.52 MPa; It was Sendangbiru sand beach. While the lowest was mortar sand beach Sukamade of 4.92 MPa. Mortar containing beach sand of Puger and Brantas river sand was the highest compression strength.

The report of gradation test of beach sand showed that grain diameter of it smaller than the size of river sand grain. Beach sand including at zone of 4. The finess modulus decrease order of beach sand was 2.51; 2.55; 3.04; 3.13; and 3.15; for beach of Pacitan (Lorok), Sendangbiru, Popoh, Puger, and Bandung respectively. The finess modulus of Brantas river sand was 4.80.

Generally, specific gravity of sand beach was smaller than the river sand. The difference of that tend to the compression strength of mortar. The strength of a high certainty mortar mass produced by a more compact (Tjokrodinuljo, 1996; Suprpto, 2001).

At the age of 14 days, the average of compression strength of mortar in composition of

sand of 0% Rs: 100% Bs was 1.7% lower than the 20% : 80% ps. The average of compression strength of mortar in composition of sand of 40% Rs: 60% Bs was 91% of the control mortar. The control mortar that consist of 1 PC: 3 sand of 100% Rs: 0% was the highest, at the age of 28 days. Further decreasing compression strength of mortar of 20% Bs: 80% Rs, be 82%, and 40% Bs: 60% Rs to be 75% of control. The lowest compression strength mortar mixed pure sand beach.

4. CONCLUSION

The usage of beach sand for building materials such as mortar can be done with the composition of 1PC cement: 3 sand composed of 20% over the beach sand and river sand of 80%. The compressive strength of that mix at age of 14 days greater than the mortar containing river sand, but it was 82% decline in the age of 28 days.

The grain of beach sand smaller than river sand. That filler material does not provide a good mortar. Combination filler material between beach sand and river sand makes better mortar than pure beach sand mortar.

The specific gravity of beach sand was greater than river sand. In contrary, the size grain of beach sand was lower than river sand.

Clay lumps test on the grain of sand beach was 0.66% to 3.41%; under 5% PUBI standard. However, the purposes of sand beach as building materials need more research.

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