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Optimization and Implication of Local Material Due to the Characteristic of Mortar in Merauke Regency – Restriction between Republic of Indonesia and Papua New Guinea

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ABSTRACT

The quality of building material is as the initial condition for a design. However, local material in Merauke Regency as the boundary of Indonesian Republic and Papua New Guinea is as the local ground sand which is needed a test for knowing the good physical and mechanical quality of aggregate for making mortar. This research uses the local material from Kampung Ivimahad-Merauke Regency and the classification is based on the gradation and dimension of maximum aggregate, Portland cement type I of Gresik cement, and water from the Laboratory of Civil Engineering, University of Musamus. The plan of stirring mortar is determined based on the gradation of maximum aggregate and the slump value. Local material which is as the ground sand is classified as a little soft sand, the aggregate soft modular is in the range of 1.4 until 2.3. Generally, the local sand in Kampung Ivimahad-Merauke Regency has the quality of aggregate as the standard condition although some aggregate quality is less under the standard condition. However, mortar of local aggregate in Kampung Ivimahad has good character so that can fulfill the standard of mortar but the demand of cement per-m^3 is relatively more than the normal mortar.

Keywords: local sand, Ivimahad, aggregate quality, mortar characteristic

INTRODUCTION

Merauke Regency as the easiest regency of Indonesian Republic and located in the boundary with Papua New Guinea, has more potential resources for supporting the infra-structure development. The sustainable development for fulfilling the residences and general facilities for the society who are living in boundary area is necessary to be carried out by considering the effectiveness and efficiency due to the increasing of society prosperity. Building material as sand and gravel geologically has not been available in the certain local area like Merauke Regency. The usage of natural resources optimally such as local material can be optional as the building material. However, local material in Merauke Regency as the boundary of Indonesian republic and Papua New Guinea is as local ground sand which is needed a test for knowing the good quality of aggregate for making mortar included the physical characteristic of aggregate as well as the mechanical characteristic of mortar. The usage of local material which is known as the local aggregate such as grown sand ia as the substitute soft aggregate for making mortar. The usage of grown sand as the base material of mortar in developing society residence and the other general facility is needed the quality test of building material.

The characteristics of aggregate will be contributed to the characteristic of mortar as the produced mortar characteristic. The relevance of material quality and the characteristic of local material needs the test for obtaining the optimization of material usage [1]. However, the building material such as sand and gravel has not been locally available, so the usage of grown sand as the local material is used as substitute aggregate. This research intends to optimize the local material and its implication due to the characteristic of mortar that the soft aggregate is made of local sand for knowing 1) the physical characteristic of ground sand such as volume-weight, unit weight, gradation, mud content, organic content; 2) the mechanical characteristic of mortar; 3) the permeability characteristic of mortar.

The result can be become as the input and rule condition in using local material for supporting the acceleration of infra-structure development especially the society residences and the other general facilities in Merauke Regency.

MATERIALS AND METHOD

Base material of Mortar

Aggregate is as the natural mineral which is functioned as the filling material in mortar mixture. This aggregate is as 70% of mortar volume. Although only as material filling, the aggregate is very influenced the characteristic of mortar, so the selection of aggregate is as the important part in making concrete mortar. In the implementation, generally the aggregate is classified into 3 groups such as stone for the aggregate with diameter

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more than 40 mm, gravel for the aggregate between 5 mm and 40 mm, and sand for the aggregate between 0.15 mm and 5 mm.

The difference of chemical composition on Portland cement which is carried out by converting the percentage of 4 main component cement can produce some kinds of cement due to the objective of using. Due to the objective of using, Portland cement in Indonesia (Specification of Building Material Part A, Building Material Non Metal, SK SNI S-04-1989-F [1]) is divided into 5 types such as Type I of Portland cement for general construction which is not needed the special condition like the other types.

Water as the building material has to be suitable with the condition as follow (standard of SK SNI S-04-1989-F [1], Specification of Building Material Part A). Water has to be clean and it does not has the content of mud, oil, and the other thing that can not be seen visually. The suspended things may not be more than 2 gram per-litre and there is no salt which can be dissolved and can damage the concrete (acid, organic essence, etc.) more than 15 gram per-litre, it does not has the content of chloride (Cl) more than 0.5 gram per-litre. Mainly for pra-tension concrete, the content of chloride may not more than 0.05 gram per-litre and has not the content of sulphate (as SO_3) more than 1 gram per-litre.

Mortar

Mortar is as building material which is made of water, sticker material (such as mud, lime, Portland cement), and soft aggregate (such as natural sand, wall breaking). Generally, mortar is used for the sticker among red stone, concrete stone on making wall, among stones on stone paving, etc. The stirring of mortar is made until it is good enough to be carried out (to be stirred and it is taken to the location of material making and it is installed on the building). The smoothing size is carried out by distribution test with the tool as distribution table. Cement mortar is made of the mix of water, Portland cement, and soft aggregate in right composition. .The composition between cement and soft aggregate volume is in the range of 1: 2 and 1:8. This mortar is seen bigger than mud or lime mortar. Therefore this type mortar is generally used for wall, pillar, column or as part of the other structure that holds load. Because of cement mortar is more firm of water than mud and lime mortar, so this kind of mortar ia also used for the outside of structure were is located under land (groundwater content).

Mortar has variety of pressure strength due to the setting and composition material. Generally the pressure strength of cement mortar is in the range of 3-17 Mpa, however for lime mortar is in the range of 0.4-1.7 Mpa. Mortar cement has the volume-weight of 1.80-2.20, but lime mortar is 1.8-1.9 [2] .

METHODS

A. Material and tool

The aggregate consists of delved sand in Kampung Ivimahad-Merauke Regency. It is classified due to the maximum aggregate gradation. Cement which is used is Portland cement type I that is produced by PT Semen Gresik with the weight of 50 kg/ pack

Water for making sample is come from clean water of Civil Engineering Laboratory, Faculty of Engineering, University of Musamus. However, sample for mortar is cube with the dimension of 70 x 70 x 70 mm. The equipment for making sample consists of cube printed of mortar and there is needed tool of mortar pressure strength test.

B. Methodology of research

Delved sand is classified into two types such as type I of maximum aggregate sand with diameter of 4.8 mm; and type II of maximum aggregate sand with diameter of 2.4 mm. At preparation step, the material consists of the observation of physical characteristic of aggregate, aggregate gradation, unit weight, volume-weght, mud content, and organic content. Mortar making is classified into two types such as type I is mortar from maximum aggregate sand with the diameter of 4.8 mm; and mortar type II is sand maximum aggregate sand with diameter of 2.4 mm. Material design is with the composition of sand and cement volume as 1 : 2 until 1 : 7. The step of sample making, sample maintenance, and sample test is carried out in series. The research variables consists of the mix variation of cement and aggregate stirring for making the relation between pressure strength and cement water factor on the same slump.

RESULTS AND DISCUSSION

Local delved sand

A. Gradation and aggregate soft modulus

If it is compared with the standard sand gradation (SNI-03-6861.1-2002 [3]), it is seen that local delved sand gradation has the trend that is classified into zona III such as sand with rather soft aggregate (but most of them is in the outside of boundary) like presented as in Figure 1 and 2. The value of aggregate soft modulus is in

the range of 1.44-1.96. Sand with the maximum aggregate of 4.8 mm and 2.4 mm has the soft modulus as 1.96 and 1.44

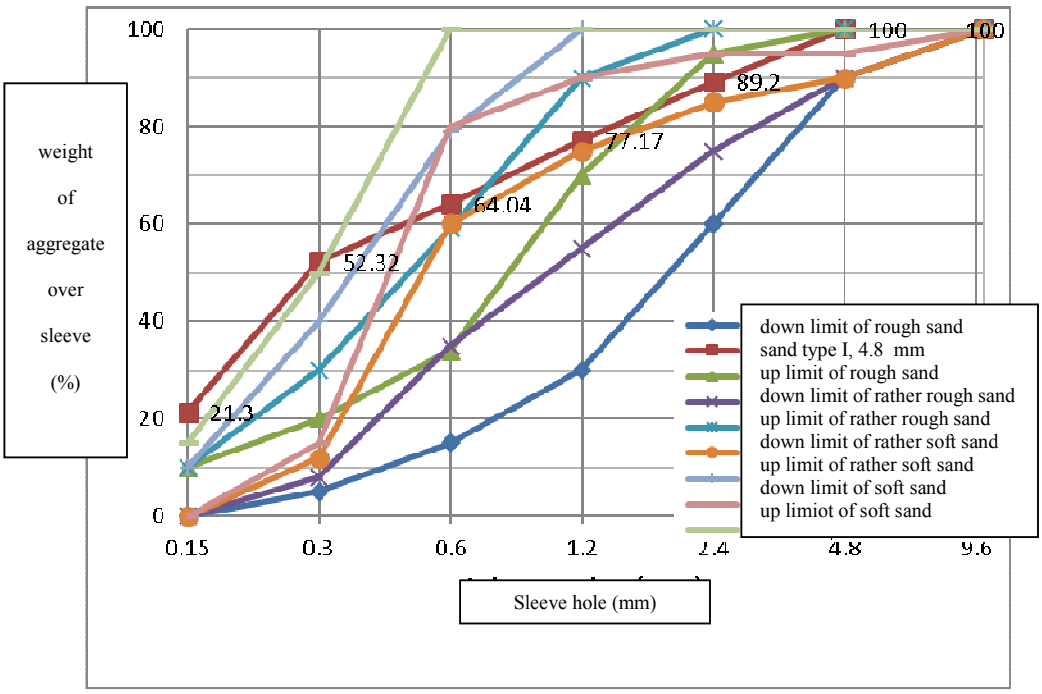

Figure 1 Gradient of sand type I with maximum aggregate of 4.8 mm due to the standard sand gradient

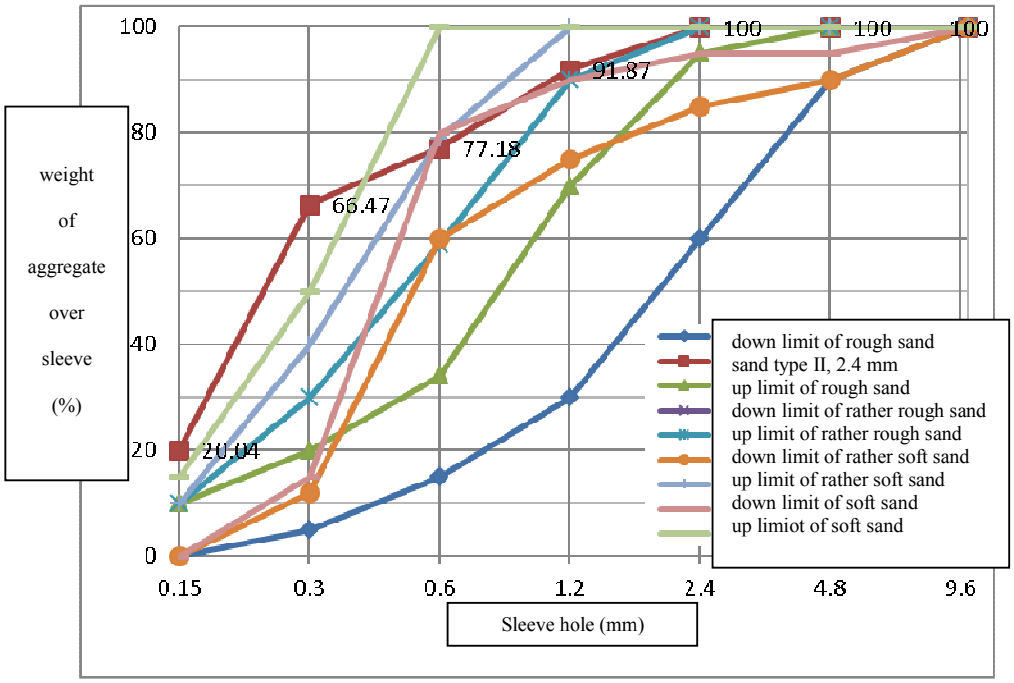

Figure 2 Gradient of sand type II with maximum aggregate of 2.4 mm due to the standard sand gradient

B. Unit weight of sand

Unit weight of sand with the maximum aggregate of 4.8 mm is 1.582 gr/ cm^3 and for the maximum aggregate of 2.4 mm is 1.557 gr/cm^3. Based on the unit weight of sand included normal aggregate, normal unit weight of sand is in the range of 1.5-1.8.

C. Volume-weight and water absorption of sand

Volume-weight of sand is between 2.5 until 2.6 and water absorption of delved sand in between 3.1% until 4.7%. The volume-weight of normal aggregate is between 2.5-2.7. Therefore, the sand is as the normal sand. Sand with the diameter less than 0.3 mm has volume-weight between 3.03 until 3.11 and water absorbed 3.29%.

D. Content of sand-mud

Content of sand-mud is in average of 2.62%. Based on the general condition of Building Material in Indonesia 1982 (PUBI-1982), part of weight that is over sieve No 200 (0.074 mm) for sand is maximum of 5%. Based on the general condition, sand which is used in this research is suitable with the condition for the material of mortar stirring and concrete.

E. Content of organic essence

Sand after being soaked with 3% of Na OH during 24 hours causes the colour of sample is almost the same as compared solution. It means that the content of organic essence in the sand is low, so the sand can be used.

Mortar

A. Composition of mix, the factor of cement-water and volume-weight

Mortar type I with the volume composition of 1: 2 until 1: 6 needs the ractor of water-cement of 0.490 until 1.250 for reaching the value of 70% until 90%.. In this condition, the volume-weight of mortar type I is between 2.3 until 2.1. Mortar type II with the volume composition of 1 : 2 until 1 : 7 needs the factor of cement-water of 0.490 until 1.490 for reaching the value of 70% until 90%. In this condition, the volume-weight of mortar type II is between 2.3 until 2.1. Mortar cement has the volume-weight of 1.80-2.20. Therefore, mortar type I and type II is as normal mortar.

B. The relation between volume ratio of cement-sand and pressure strength of mortar

The relation between volume ratio of cement-sand and pressure strength of mortar as seen in Figure 3, it shows that mortar type I with maximum aggregate delved sand of 4.8 mm and the composition of cement-sand volume is between 1: 2 until 1: 6 and it has the pressure strength of mortar as 25.579 MPa until 5.527 MPa. For the mortar Type II with the maximum aggregate delved sand of 2.4 mm and the composition of cement sand volume between 1 : 2 until 1 : 7 has the pressure strength of mortar of 21.539 MPa until 2.706 MPa. It is as the Merauke aggregate which is compared with cement mortar from Sungai Boyong sand with rather soft gradation [4] and it is seen that pressure strength of the third mortar are almost the same.

C. The relation between factor of cement water and pressure strength of mortar

The relation between the factor of cement warer and the pressure strength of mortar Type I and Type II is presented as in Figure 4. Mortar Type I from maximum aggregate delved sand of 4.8 mm with the cement water factor of 0.490 until 1.250 has the pressure strength of mortar of 25.579 MPa until 5.527 MPa. Mortar type II from maximum aggregate delved sand of 2.4 mm with the cement water factor of 0.490 until 1.490 has the pressure strength of mortar on 21.539 MPa until 2.706 MPa.

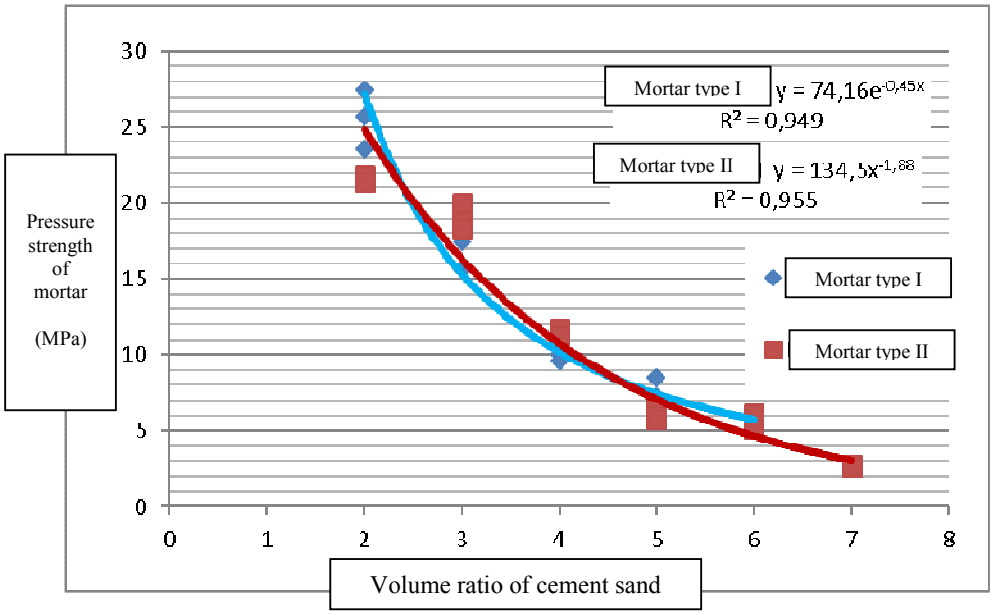

Figure 3 The relation between cement sand volume ratio and the pressure strength of mortar Type I and II

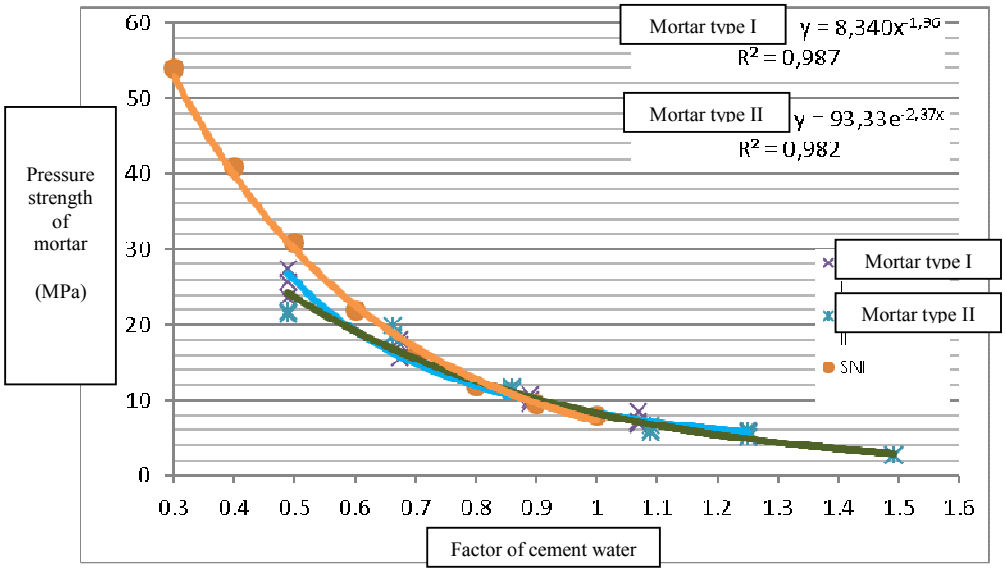

Figure 4 The relation between cement water factor and the pressure strength of mortar Type I and II

D. The relation between cement weight and pressure strength of mortar

The relation between one m^3 mortar of cement weight and the pressure strength of mortar as seen in Figure 5, it shows that mortar Type I with the cement weight of 575.718 kg until 215.26 kg has the mortar pressure strength of 25.579 MPa until 5.527 MPa. However, mortar Type II with the cement weight of 593.19 kg until 187.82 kg has the mortar pressure strength of 21.539 MPa until 2.706 MPa.

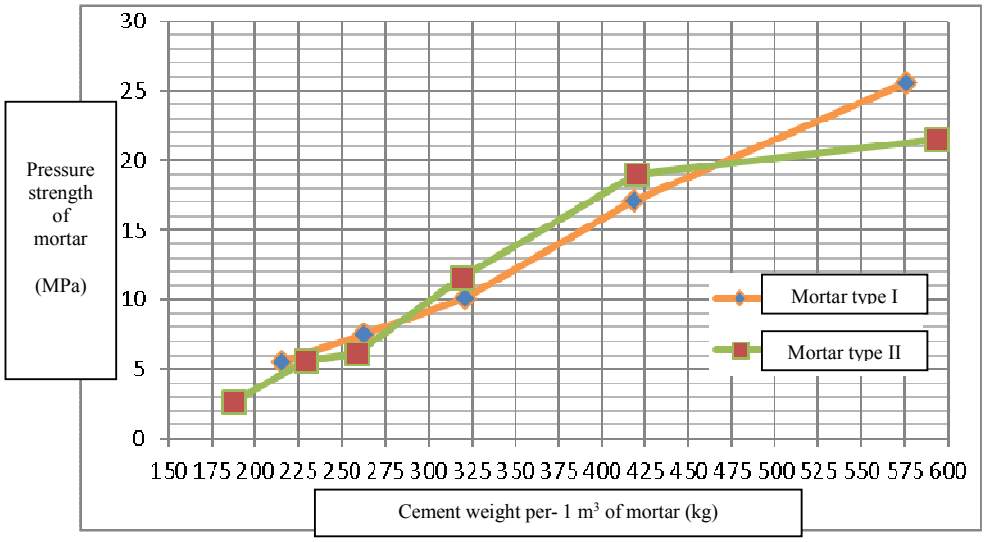

Figure 5 The relation between every m3 mortar of cement weight and the mortar pressure strength

E. The relation between volume ratio of cement-sand with water absorption of mortar

The relation of cement sand volume ratio and the water absorption of mortar Type I and II is presented as in Figure 6. Mortar Type I with the cement sand volume composition of 1 : 2 until 1 : 6 and water cement factor of 0.490 until 1.250 has the water absorption for 10 minutes of 2.858% until 6.322% and for 24 hours is 9.224% until 12.498%. However, mortar Type II with the cement sand volume composition of 1 : 2 until 1 : 7 and the cement water factor of 0.490 until 1.490 has the water absorption for 10 minutes of 2.987% until 9.267% and for 24 hours is 8.523% until 13.307%.

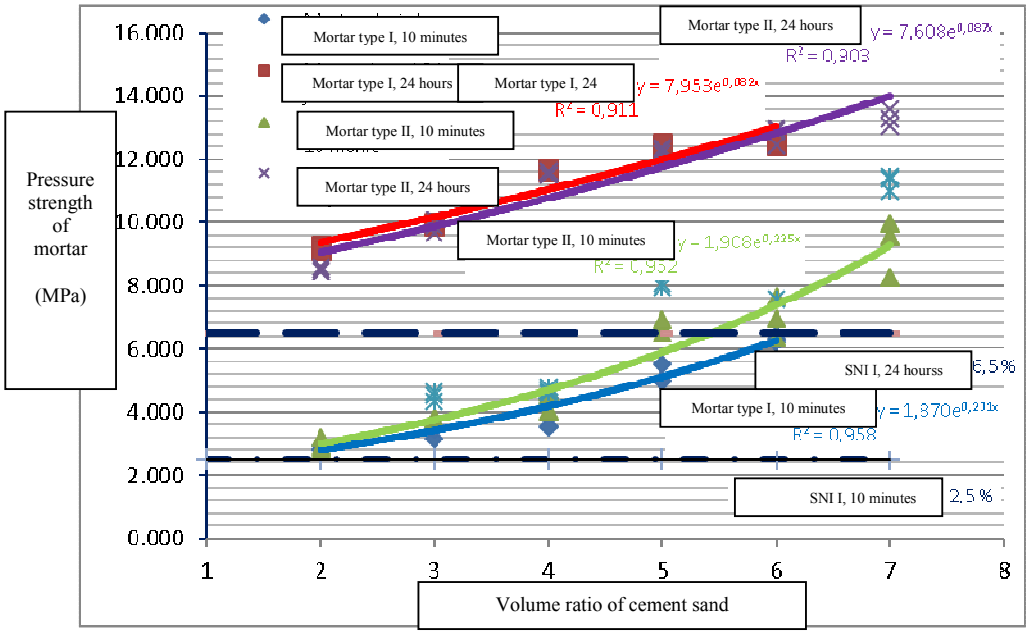

Figure 6 The relation between cement sand volume ratio and water absorption factor of mortar Type I and II

CONCLUSION

Based on the research result, it can be concluded as follow:

1. Local sand in Kampung Ivimahad -Merauke Regency-Papua Province is:
   a. The gradient and soft modulus of sand aggregate has a trned to be classified as sand with rather soft aggregate. There is sand with the maximum aggregate of 4.8 mm, modulus of soft aggregate is 1.96, and for maximum aggregate of 2.4 mm has the soft aggregate modulus of 1.44
   b. Volume weight of sand with maximum aggregate of 4.8 mm is 1.582 gr/cm^3 and for the maximum agrewgate of 2.4 mm is 1.557 gr/cm^3.
   c. Volume weight of sand is between 2.5 until 2.6 and the sand water absorption is between 3.1% until 4.7% included the normal sand. Sand with the diameter of aggregate less than 0.3 mm has the volume weight between 3.03 until 3.11 and the water absorption is 3.29%
   d. The average content of sand mud is 2.62%, so the sand which is used in this research is suitable with the condition of material for mortar and concrete stirring.
   e. .The content of sand organic essence after being soaked with NaOH of 3% during 24 hours causes the colour of sample is lamost the same as the colur of comparison solution. It means that the content of organic essence in sand is low, so the sand can be used.
2. Mortar Type I (maximum aggregate size of 4.8 mm)
   The characteristic of mortar-cement type I is seen that on design of cement sand volume composition between ! : 2 until 1 : 6. It produces the cement water factor of 0.490 until 1.250 for reaching the value of 70 until 90%. However, it also produces the volume weght of mortar between 2.3 until 2.1; cement weight per- 1 m^3 mortar is 575.718 kg until 215.263 kg and the mortar pressure strength is 25.579 MPa until 5.527 MPa.
3. Mortar Type II (maximum aggregate size of 2.4 mm)
   The characteristic of mortar-cement type II is seen that on design of cement sand volume composition between ! : 2 until 1 : 7. It produces the cement water factor of 0.490 until 1.490 for reaching the value of 70 until 90%. However, it also produces the volume weght of mortar between 2.3 until 2.1; cement weight per- 1 m^3 mortar is 593.199 kg until 287.825 kg and the mortar pressure strength is 21.539 MPa until 2.706 MPa.
4. Generally, the local aggregate in Kampung Ivimahad-Merauke has good character of aggregate and it can be classified to be suitable with the standard of aggregate characteristic although some of aggregate characteristic is less under the condition.
5. Generally, mortar of local aggregate in Kampung Ivimahad-Merauke has good character so it can be suitable with the standard characteristic of mortar, but there is trend that demand of per-m^3 cement is more than normal mortar.

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