

Potential of excavation of c sand in Aek Bolon Village as a building material based on the material feasibility requirements test for concrete construction

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ABSTRACT

This study analyzed the feasibility of mountain sand in Aek Bolon Village, Balige District, as a fine aggregate in the concrete mixture. The methods used are exploratory and experimental research through laboratory tests at the University of Medan including sludge content, filter analysis, content weight, moisture content, specific gravity, absorption, and compressive strength of concrete aged 28 days. The test results showed a sludge content of 1.25%, Modulus of Fineness (FM) of 2.78 (medium sand), loose content weight of 1.26 gr/cm³ and density of 1.36 gr/cm³, moisture content of 3.63%, specific gravity of 2.40 gr/cm³, absorption of 2.3%, and an average compressive strength of concrete of 25.50 MPa (SNI 7656-2012). All parameters meet the fine aggregate feasibility standard. Thus, the mountain sand of Aek Bolon Village is suitable for use as a concrete mixture for building construction.

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1. INTRODUCTION

As one of the aspects that are needed in concrete manufacturing and construction, of course, sand has a very important role. However, its existence depends on whether or not there is river sand mining in an area will determine the availability or price that will be determined for each unit of river sand volume. The above situation requires thinking that it is important to pay attention to market aggregates that are not only sourced from rivers and mountains.

Aek Bolon Village is one of the villages located in Balige District, Toba Regency. This village has a mountain sand content that allows it to be used as a building material. However, it is necessary to test the mountain sand of Aek Bolon Village to understand and find out how much potential it has.

The research is in the background because the surrounding community often uses excavated sand C from Aek Bolon Village as a Building Material Based on the Material Feasibility Requirements Test as a substitute for fine aggregates for making concrete. This study was conducted to determine the quality of concrete with fine aggregates made of sand from Mount Aek Bolon Village, Balige District, which was tested for compressive strength at the age of 28 days.

Based on the importance of development and the role of sand that is urgently needed, it is necessary to conduct a research entitled "The Potential of Sand C Excavation in Aek Bolon Village

as a Building Material Based on the Feasibility Requirements Test of Concrete Construction Materials Materials".

The purpose of this study is to find out the Results of the Sand Sand Sludge Content Testing of Mountain Sand Village Aek Bolon Village, Balige District, Determine the Sand Aggregate Analysis of Aek Bolon Village Mountain Aggregate, Balige District , Sand Aggregate Analysis of Aek Bolon Village Mountain Sand Aggregate Knowing the specific gravity and absorption rate of sand in Aek Bolon Village, Balige District, Knowing the compressive strength of concrete Using sand in the mountains of Aek Bolon Village, Balige District.

2. METHOD

This research is an exploratory and experimental research, in this case exploratory is intended to go down to the field of the research point, namely Aek Bolon Village to collect the data needed in the research. The experiment in this study is intended to test the feasibility of sand taken from the research site through laboratory testing. The research that will be carried out by the author is absolutely to find out the potential of mountain sand found in Aek Bolon Village as a concrete mixture material. The tests carried out are Sand Organic Content/Colorimetric Test, Aggregate Sieve Analysis, Aggregate Content Weight, Specific Gravity, Absorption/Absorption and Aggregate Water Content Check.

This research was conducted in Aek Bolon Village, Balige District, Toba Regency. North Sumatra Province which is located at the coordinate point $2^{\circ}18'10.0''N$ $99^{\circ}03'44.5''E$



Figure 1. Map of the Research Location Point
Source: Research 2025.

3. RESULTS AND DISCUSSION

Based on the results of the study, namely sampling obtained from Desa Aek Bolon, Balige District, Toba Regency. North Sumatra Province, which is located at the coordinate point of $2^{\circ}18'10.0''N$ $99^{\circ}03'44.5''E$, several tests were carried out to find the quality of mountain sand at the research location

3.1 Fine Aggregate

3.1.1 Sieve Analysis

Sieve analysis testing was carried out to find the size of sand grains contained in the sample to determine the suitability or suitability of the size of sand grains as building materials, following the results of the analysis of the sieve analysis of the research sample. The following is a recapitulation of the sieve passed from the 4 samples that were tested

Table 1. Summary of test results Filter analysis

No. Sieve	Sample				Average
	Sample 1	Sample 2	Sample 3	Sample 4	
4	99,6	99,5	99,7	99,3	99,53
8	98,6	98,6	99,1	98,8	98,78
16	94,3	94,5	94,6	94,9	94,58
30	69,1	69,4	69,7	71,2	69,85
50	35,4	35,8	35,5	35,6	35,58
100	24,5	25,9	21	21,7	23,28
200	0	0	0	0	0,00

Source: Research, 2025

Based on the graph above, a graph can be formed to show the gradation of sand accompanied by the upper and lower boundaries.

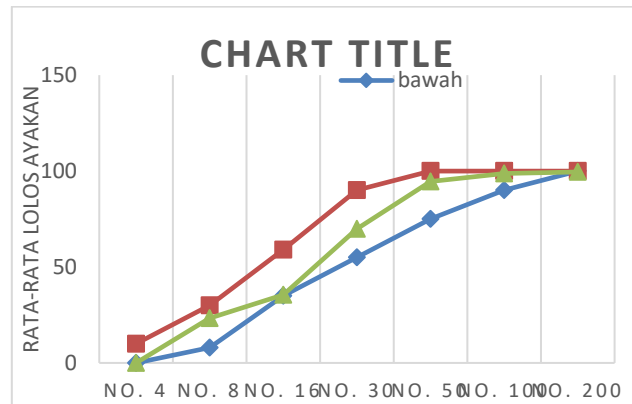


Figure 2. Fine Aggregate Sieve Analysis Graph
Source: Research, 2025

Fineness *modulus* is an index used to measure the fineness or roughness of aggregate grains. The grain fineness modulus (FM) is defined as the cumulative percent of the remaining sieve over sieve No. 100 (150 μ m) divided by one hundred. The greater the fine modulus value indicates that the larger the aggregate grains. The fine modulus of fine aggregate grains ranges from 1.5 – 3.8 (SNI 03 – 1750 – 1990).

The degree of fineness (roughness) of an aggregate is determined by the *Fineness Modulus* with the following limitations:

Fine sand : 2,20 < FM < 2,60

Medium sand: 2,60 < FM < 2,90

Coarse sand: 2,90 < FM < 3,20

FM values can be searched by the formula:

$$FM = \frac{\sum \% \text{ cumulative retained}}{100} \quad (1)$$

The following are the results of the calculation of the modulus value of the fineness of the sample items tested:

$$FM1 = \frac{\sum \% \text{ cumulative retained}}{100} = \frac{278,5 \%}{100} = 2,78$$

$$FM2 = \frac{\sum \% \text{ cumulative retained}}{100} = \frac{276,3\%}{100} = 2,76$$

$$FM3 = \frac{\sum \% \text{ cumulative retained}}{100} = \frac{280,4 \%}{100} = 2,8$$

$$FM4 = \frac{\sum \% \text{ cumulative retained}}{100} = \frac{278,5 \%}{100} = 2,78$$

$$FM_{Average} = \frac{2,78+2,76+2,8+2,78}{4} = 2,78$$

Based on the results of the calculation above, it is known that the average FM value is 2.78, therefore sand is included in the medium sand group (2.60 < FM < 2.90).

3.1.2 Moisture Content Testing

Soil moisture content is the ratio of the weight of water in a soil unit to the dry weight of the soil, so the greater the weight of dry soil, the smaller the amount of moisture content produced. This test aims to find out the moisture content of the soil sample being studied. The results of the soil moisture content test can be seen in Table 2 below. The following is a summary of the table of water content analysis results from 4 research samples:

Table 2. Sample Moisture Content Analysis Results

No	Sample Initial Weight	Dry Sample Weight	water content %
1	1000 gr	969 gr	3,199 %
2	1000 gr	955 gr	4,712 %
3	1000 gr	962 gr	3,950 %
4	1000 gr	974 gr	2.669 %
Average	1000 gr	965 gr	3,6325 %

Source: Research, 2025

Based on the table above, it is known that the 4 samples that have been tested are known to be feasible because the moisture content value after being tested and calculated is below 5%.

3.1.3 Specific Gravity

For this specific gravity test, it is carried out to determine the specific gravity (bulk), surface dry saturated specific gravity, apparent specific gravity, and water absorption rate from the aggregate tested. For the method of testing specific gravity on aggregates, reference from SNI 03-1970-1990 is used. The following are the results of the specific gravity test Based on the results of the elaboration of the calculation of specific gravity and water absorption in sand, the results of specific gravity and absorption are summarized as in the following table:

Table 3. Test Results Specific Gravity and Absorption Percentage

Sample	Berta Types	Water absorption
Sample 1	2.4 gr/cm ³	2,5 %
Sample 2	2.5 gr/cm ³	2,5 %
Sample 3	2.31 gr/cm ³	1,6 %
Sample 4	2.4 gr/cm ³	2,5 %
Average	2.40 gr/cm ³	2,3 %

Source: Research, 2025

Based on the results of the research related to specific gravity, it was found that 4 samples were tested sourced from mountain sand from the Aek Bolon Village area, Balige District, Toba Regency. It was found that the specific gravity in the feasible category was 2.40 gr/cm³, while for absorption it is known that the acquisition value in the feasible category is 2.3%.

3.1.4 Sludge Rate

Table 4. Sludge Rate Test Results

Yes	Initial Weight Loss	Net Weight
1	500 gr	495 gr
2	500 gr	495 gr
3	500 gr	490 gr
4	500 gr	495 gr

Source: Research, 2025

Based on the table above related to the sludge content in the 4 samples tested, it was found that samples 1, 2 and 4 had the same sludge content of 1%, while sample no. 3 had a more sludge content of 2%, with an average of 1.25%. Therefore, the sand samples are classified as suitable for use as a mixed material for buildings.

3.1.5 Fine Aggregate Content Testing

The unit weight of SSD sand was obtained at 1,520 gra/cm³. This unit weight serves to find out whether the aggregate has cavities or tightness. The greater the unit weight obtained, the denser the aggregate surface. This affects the concrete processing process in large quantities and affects the compressive strength of concrete. The following is a summary of the results of the loose content weight test and the sample content weight.

Table 5. Summary of the results of the Fine Aggregate Unit Weight Test

Yes	Weight of Loose Contents	Solid Fill Weight
Sample 1	1.23 gr/cm ³	1.41 gr/cm ³
Sample 2	1.29 gr/cm ³	1.39 gr/cm ³
Sample 3	1.27 gr/cm ³	1.32 gr/cm ³
Sample 4	1.25 gr/cm ³	1.33 gr/cm ³
Average	1.26 gr/cm ³	1.36 gr/cm ³

Source: Research, 2025

Based on the table above, it shows that both the weight of the loose content and the weight of the solid content are classified as feasible where the permissible standard is at least 1.2 gr/cm³ (SII No. 52-1980).

3.2 Coarse Aggregate

The following is the analysis/testing of the coarse aggregate that will be used as a mixture for making sample concrete

3.2.1 Berta Type and Absorption

For this specific gravity test, it is carried out to determine the specific gravity (bulk), surface dry saturated specific gravity, apparent specific gravity, and water absorption rate from the aggregate tested. For the method of testing specific gravity on aggregates, reference from SNI 03-1970-1990 is used. The following are the results of the specific gravity test

Table 6. Gross Aggregate Specific Gravity Test Results

Yes	Measurement	Units	Sample 1	Sample 2	Average
1	SSD Weight (Bj)	gr	500	500	500
2	Weight In Water (Ba)	gr	320	325	322,5
3	Oven Dry Weight (Bk)	gr	490	492	491
4	BJ Bulk = BK/(Bj-Ba)		2,72	2,81	2,765
5	BJ SSD = Bj/(Bj-Ba)		2,7	2,85	2,775
6	BJ Pseudo = Bk/(Bk-Ba)		2,88	2,94	2,91
7	Water Absorption = (Bj-Bk) Bk x 100 %	%	2,04	1,62	1,83

Source : Research, 2025

Based on the results of the calculation above, it was found that the SSD sample weight was 2.7 where the value was considered feasible when compared to the permitted conditions, which were 1.6 – 3.1. Furthermore, for absorption, it was found that the water absorption value was 2.04 for sample 1 and 1.62 for the second sample, where this value was considered suitable for use.

3.2.2 Gross Aggregate Contents Weight

The following is explained the results of the test and the calculation of the weight of the coarse aggregate release content:

Table 7. Gross Aggregate Loose Contents Weight Test Results

No	Measurement	Units	Sample 1	Sample 2	Average
1	Empty Cylinder Weight (W1)	gr	11000	11000	11000
2	Cylinder Weight + Sample (W2)	gr	18500	18100	18300
3	Aggregate Weight (W3)	gr	7500	7100	7300
4	Volume Silinder	Cm3	5298,7	5298,7	5298,7
5	Loose Fill Weight = W3/V	gr/C m3	1,41	1,34	1,375

Source : Research, 2025

Based on the results of the table above, it was found that the weight of the loose content of the coarse aggregate that was tested was 1.41 while the second sample was 1.34, this shows that this value is suitable for use according to the permissible limit, which is at least 1.2 gr/cm³. The following is explained the results of the test and the calculation of the weight of the coarse aggregate release content:

Table 8. Gross Aggregate Solid Content Weight Test Results

No	Measurement	Units	Sample 1	Sample 2	Average
1	Empty Cylinder Weight (W1)	gr	11000	11000	11000
2	Cylinder Weight + Sample (W2)	gr	19100	18800	18950
3	Aggregate Weight (W3)	gr	8100	7800	7950
4	Volume Silinder	Cm3	5298,7	5298,7	5298,7
5	Loose Fill Weight = W3/V	gr/Cm3	1,52	1,47	1,495

Source : Research, 2025

Based on the results of the table above, it was found that the weight of the solid content of the crude aggregate tested was 1.52 in sample 1.52 while the second sample was 1.47, this shows that this value is suitable for use according to the permissible limit, which is at least 1.2 gr/cm³.

3.2.3 Filter Analysis

Based on the results of the calculation of the gross aggregate analysis, the recapitulation table was obtained as follows:

Table 9. Average pass sieve analysis of coarse aggregate sieve

Strainer Size (mm)	Pass Sample 1	Pass Sample 2	Average
40	99,92	99,8	99,86
19	66,84	67,72	67,28
12,5	35,76	36,44	36,1
9,5	10,48	10,52	10,5
4,75	0	0	0
2,36	0	0	0
1,18	0	0	0
0,6	0	0	0
0,3	0	0	0

Source : Research, 2025

Based on the results of the table above, a graph was made to show whether the results of the coarse aggregate filter analysis test were qualified or not.

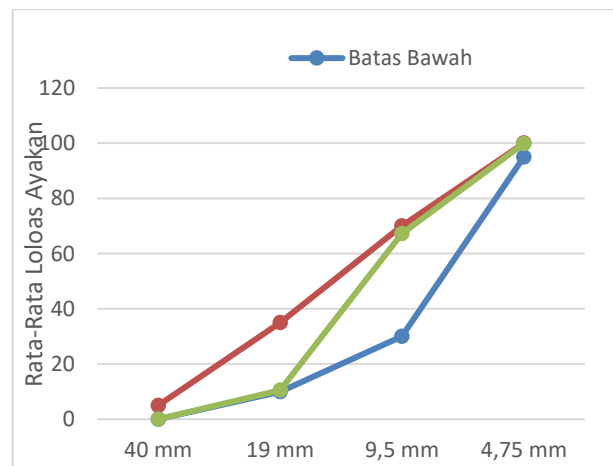


Figure 3. Rough Aggregate Sieve Analysis Graph

Source : Research, 2025

3.2.4 Gross Aggregate Moisture Content

The following are the results of the crude aggregate moisture content test that will be used in the study.

Table 10. Results of Crude Aggregate Moisture Content Test

No	Measurement	Units	Sample 1	Sample 2
1	Aggregate Weight	gr	500	500
2	Heavy Dry Oven	gr	490	493
3	Up Air	%	2,04	1,41
Average			1,72	

Source : Research, 2025

Based on the results of the test and the calculation of the moisture content of the coarse aggregate, it is explained that the coarse aggregate sample has a moisture content of 1.72%, when it is associated with water absorption in the previous test, it was found to be absorption of 1.83%, meaning that the aggregate is dry.

3.2.5 Recapitulation of Gross Aggregate Examination Results

Based on the coarse aggregate test, a recapitulation is given related to the aspects tested on the coarse aggregate as follows:

Table 11. Recapitulation of Gross Aggregate Examination Results

No	Inspection	Results
1	Screening Analysis (MHB)	6,86
2	Specific Gravity of SSD	2,77
3	Absorption	1,83 %
4	Up Air	1,72 %
5	Loose Fill Weight	1,375
6	Solid Fill Weight	1,495

Source : Research, 2025

3.3 K-300 Mix Design

The making of concrete samples in this study requires a calculation of the material to be used, this ensures how the expected strength of concrete can be formed based on the proportion of the material used and the explanation.

Table 12. Job Mix Concrete Plan

No	Description	Value
1	Strong Pressure Signaled	25 MPa (28 days)
2	Standard Deviation	4,2
3	Margin Added Value	12 MPa
4	Average compressive strength required	25 MPa + 12 MPa = 37 MPa
5	Types of Cement	Portland
6	Aggregate Type - Fine Aggregate	Mountain Sand
	- Coarse Aggregate	Broken Stone
7	Free Cement Water Factor	0,52
8	Maximum Cement Water Factor	0,6
9	Slump	60 – 180
10	Maximum Aggregate Size	40 mm
11	Free Moisture Content	185 Kg/m ³
12	Amount of Cement	355.76 Kg/m ³
13	Maximum Cement Quantity	843.8808 Kg/m ³
14	Minimum Cement Quantity	1165.3592 Kg/m ³
15	Customized Cement Water Factor	0,52
16	Large Arrangement of Fine Aggregate Grains	District 2
17	Aggregate Arrangement Rough or combined	
18	Percent Fine Aggregate	42 %
19	Percent Fine Aggregate Relative Specific Gravity Aggregate (Surface Dry)	$= \frac{42}{100} \times 2,2 \times 2,77 \frac{58}{100}$ $= (0,42 \times 2,40) + (0,58 \times 2,77)$ $= 1,008 + 1,606$ $= 2,614$
20	Concrete Fill Weight	2550 Kg/m ³
21	Combined Aggregate Rate	2009.24 Kg/m ³
22	Fine Aggregate Rate	Wagr. h = Kh x Wagr. Camp Wagr. h = 42 % x 2009.24 Kg/m ³ Wagr. h = 843.8808 Kg/m ³
23	Crude Aggregate Rate	Wagr. k = Kh x Wagr. Camp Wagr. k = 58 % x 2009.24 Kg/m ³ Wagr. k = 1165,3592 Kg/m ³
24	Mixed Proportions -	
	- Each m ³	o Semen = 355.76 Kg/m ³
	- Each m ³ test mix	o Air = 185 Kg/m ³
		o Fine Aggregate = 843.8808 Kg/m ³
		o Gross Aggregate = 1165.3592 Kg/m ³

Source : Research, 2025

Table 13. Mix Design Beton K-300

Ingredients	Volume 1m ³	Cylinder Material Volume	Test Volume per material Test Cylinder	Bandages Düsseldorf
Semen	355.76 Kg/m ³	0,005298 m ³	1.8848 Kg/m ³	1
Fine Aggregate	843.8808 Kg/m ³	0,005298 m ³	4.4709 Kg/m ³	2,37
Coarse Aggregate	1165.3592 Kg/m ³	0,005298 m ³	6.17407 Kg/m ³	3,27
Air	185 l/m ³	0,005298 m ³	0.980 kg/m ³	0,52

Source : Research, 2025

3.3.1 Proportion of Concrete Mix Correction Factor

To find the exact number related to the amount of each concrete mixture material, it is therefore important to make correction calculations to confirm each material. The following are the details of the calculation of water correction, fine aggregate and coarse aggregate:

Volume Requirements for 12 test pieces

$$\text{Volume} = 3.14 \times r^2 \times t \times 12$$

$$\text{Volume} = 3,14 \times (0,075)^2 \times 0,3 \times 12$$

$$\text{Volume} = 0,005298 \text{ m}^3 \times 12$$

$$\text{Volume} = 0,063 \text{ m}^3$$

- Water = 185 Kg/m³ x 0.063 m³ = 11.76 l/m³
- Cement = 355.76 Kg/m³ x 0.063 m³ = 22.41 kg/m³
- Fine Aggregate = 843.8808 Kg/m³ x 0.063 m³ = 53.16 kg/m³
- Coarse Aggregate = 1165.3592 Kg/m³ x 0.063 m³ = 73,4` kg/m³

The following is a recap of the material needs for making research concrete

Table 14. Recap of the requirements of 25 MPa Concrete Material

Ingredients	Volume 1m ³	Test Material Volume for 12 Cylinders
Air	185 l/m ³	11.76 l/m ³
Semen	355.76 Kg/m ³	22.41 kg/m ³
Fine Aggregate	843.8808 Kg/m ³	53.16 kg/m ³
Coarse Aggregate	1165.3592 Kg/m ³	73,4` kg/m ³

Source : Research, 2025

3.4 Slump Test Testing

Slump test is carried out to find out how stable the concrete is when it is formed as evidenced by the height of the resistance of the cone shape that has been formed based on a predetermined concrete mixture. The following are the results of the slump test:

Table 15. slump test results

No	Sample	Slump (cm)
1	I	12
2	II	9,5
3	III	11
4	IV	10,5

Source : Research, 2025

The results of the slump test found that the 4 groups of samples tested produced slump values that were relatively close to the range between 9.5 cm to 12 cm. This shows that the better the stirring, the more evenly distributed the mixture will be, so that the binding between aggregates is better so that the slump value is better.

3.4.1 Concrete Compressive Strength Testing

Concrete that has been formed is based on a mixture of fine aggregates, coarse aggregates and cement as in the one that has been calculated above. The concrete that has been formed is based on 4 extraction points in the same area with each point consisting of 3 samples, this is intended to maximize the test results. Here is the sample load

Table 16. Test Results Sample Weight and Compressive Strength of Sample

No	point	Sample	Sample Weight	Compressive Strength (kN)
1	I	1	12,213	453
		2	12,075	451
		3	12,151	448
2	II	1	12,082	456
		2	12,143	454
		3	12,512	447
3	III	1	12,054	443
		2	12,324	452
		3	12,271	462
4	IV	1	12,018	444
		2	12,382	446
		3	12,271	458

Source : Research, 2025

The research was carried out on 4 mountain sand extraction points at the research site, which was then tested 3 samples for each point, finding relatively similar results, this concerns the weight of the sample and the compressive strength produced. The weight of the sample that was transcribed for the 12 samples tested found an average sample weight of 12,208 Kg.

The following are the results of the recapitulation of the calculation of the compressive strength of concrete for 12 samples divided into 3 collection points with three samples each at each point

Table 17. Compressive Strength of Concrete

No	Point	Sample	Sample Weight (kg)	Compressive Strength (MPa)	Average (MPa)
1	I	2	12,213	25,6476	25,5154518
		3	12,075	25,5343	
		1	12,151	25,3645	
2	II	1	12,082	25,8174	25,6098136
		2	12,143	25,7042	
		3	12,512	25,3079	
3	III	1	12,054	25,0814	25,6098136
		2	12,324	25,5909	
		3	12,271	26,1571	
4	IV	1	12,018	25,138	25,43986
		2	12,382	25,251	
		3	12,271	25,9306	

Source : Research, 2025

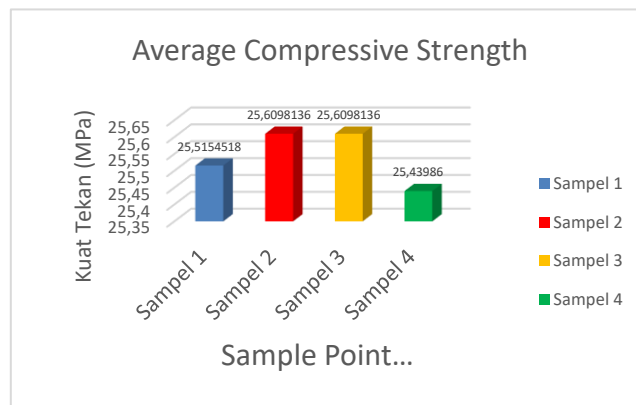


Figure 4. Sample compressive strength graph

Source : Research, 2025

Based on the results of the compressive strength calculation after measurements were carried out in the laboratory, data was found as in the table above where the samples that had been taken at point 1 were made of concrete based on the mix design, it was found that the average compressive strength was 25.5154 MPa, for sample testing at point 2 with 3 samples found the average strength of concrete was 25.6098 MPa, for point 3 with three test samples found an average compressive strength of 25.6098 and point 4 as much as three samples with an average compressive strength of 25.2512 MPa. However, overall the concrete samples that had been formed using fine aggregate from the study site found a decent concrete strength with an average of 25.5437 MPa.

4. CONCLUSION

Based on the results of research and testing of mountain sand samples from Aek Bolon Village, Balige District as a concrete mixture material, the following conclusions were obtained: The sludge content in the 4 samples tested averaged 1.25%, still within safe limits. Sieve analysis showed an FM value = 2.78, so it was in the category of medium sand. The weight of loose and solid contents meets the standard ($\geq 1.2 \text{ gr/cm}^3$, SII No. 52-1980). The moisture content of the entire sample $< 5\%$, so it is considered feasible. Sand specific gravity = 2.40 gr/cm^3 and absorption 2.3%, both in the feasible category. The average compressive strength of concrete = 25.4966 MPa, so sand is suitable for use as a concrete mixture. Based on the research that has been conducted, the author gives some suggestions as follows: It is necessary to conduct further research with variations in concrete lifespan (7, 14, 21, and 28 days) to determine the development of the compressive strength of concrete in more detail. It is necessary to conduct research with variations in the comparison of fine

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and coarse aggregates, in order to provide a broader picture of the quality of concrete with the sand mixture of Aek Bolon Village. Comparative research is needed between the mountain sand of Aek Bolon Village and other types of sand (river sand, sea sand, or sand from different locations) to obtain comparative data in the selection of the best material for concrete. For the community or construction actors, the use of sand in Aek Bolon Village can be an alternative building material that is economical and feasible, but must still pay attention to the applicable concrete quality standards.

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