Effect of additive type D and F on concrete strength capacity by using aggregate type, size, and content: Lumajang sand – Bangkalan gravel

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Abstract. Bangkalan district has the potential unallocated aggregate to be applicated as a concrete mixture in the form of fine aggregates (sand) and coarse aggregates (gravel). In fact, Bangkalan aggregate implies excellent structure, so this material is rarely used as a mixture of concrete because with its fine structure the quality of the concrete produced will be less good. To maximize the use of aggregates from Bangkalan, a concrete mixture design analysis is conducted. The study is based on a test of the physical properties which are classified into five variations. Variation one implies a combination of 5/10 and 10/20 use of gravel and sand from Bangkalan when modification two only change the subject of Bangkalan sand to Lumajang sand with the same proportion. Variation three is treated a combination two with a given 0.3% of additive type D. The variation is increased to be added more additive in variation four with 0.6 % type F. As a final variation, with the same proportion of Lumajang sand and Bangkalan gravel of 5/10 and 10/20 combined with 0.3% additive type D and 0.6% additive type F. The capacity is compared based on physical properties and compression test. As a result, the best proposed design is variation three with a compression test over standard design with 29.44 MPa.

Keywords: Additive, coarse aggregate, fine aggregate, variation, mix design

1. Introduction

Typically, all aggregates from any places can be used as concrete mixes. one of the example is from the Bangkalan district, Madura. In Bangkalan, the unallocated aggregate is available in the huge amount of which possibly be used as concrete-mixture materials, namely Fine Aggregate (sand) and quite abundant coarse (gravel) aggregates. However, Bangkalan sand has a very fine structure, this material is rarely used as a mixture of concrete because with its fine structure the quality of the concrete produced will be less good, so in Bangkalan, the use of aggregate consider to be taken from Java Island for example from Lumajang which is famous for its aggregate quality which is very good as a concrete mixture.

To optimize the use of fine aggregates and coarse aggregates of size 5/10 and 10/20 from Bangkalan on concrete mixtures, it is necessary to test the physical properties of these aggregates, so that it can be seen whether the aggregates can be used for concrete mixes. Concrete specimens with fine aggregates and coarse aggregates from Bangkalan were compared with the use of fine aggregates from Lumajang, coarse aggregates of 5/10 and 10/20 sizes from Bangkalan added with additives of type D and type F to achieve concrete compressive strength above 25 Mpa. For that purpose, the aggregate form Bangkalan could be considered to be applicated as the primary material as a concrete mixture.

2. Literature review

2.1. Previous Research

Handojo and Sugiharto [1] explained with the title Potential Use of Paterongan Gravel, Torjun and Omben on Madura Island for concrete structures. The use of Madurese gravel from Peterongan, Torjun, and Omben. In general, it can be said that the physical properties of the gravel are close to the same as gravel from Mojokerto or Pasuruan. The use of Peterongan, Torjun and Omben gravel for design mixture is 225 kg / cm^2, so Paterongan and Omben gravel are recommended only for concrete rebates, while gravel from Torjun may still be used for concrete structures with repairs gradation. The following research, Saadha and Karyoto [2] with the function of utilization of local materials as a mixture of the fine aggregate composite beam regarding deflection, with the compressive strength of the planned concrete 20 Mpa obtained by the results of compressive strength of concrete using langkap sands of Bangkalan. The result explained that concrete compressive strength of study still under the design code 15.73 MPa.

Then, Sujatmoko [3] was conducted the Optimization of Chalk Stone Waste Usage as a Substitute of Rough Aggregate to 17.5 Mpa Concrete Compressive Strength and Its Effect on Time and Cost Analysis in Banyuwangi using FAS 0.55 and 0.6. It is showed that Limestone waste could be used as coarse aggregate in the concrete mixture, besides that FAS is very influential on the compressive strength of the concrete produced, where with a higher cement water factor it will reduce the compressive strength of the concrete. This research is supported by Research Mukti et al. [4] with the Excess of Javanese Broken Stone from Madura as coarse aggregate to Concrete Compressive Strength With the concrete compressive strength of 15-25 Mpa. From the results of the study obtained the maximum concrete compressive strength using broken stone from Java reached 32 Mpa while using broken stone from Madura reached only 28 Mpa.

Pertiwi and Choiriah [5] analyzed the study of Local Aggregate of Bangkalan for Normal Concrete Mixture, obtained the results of concrete compressive strength using aggregates from Bangkalan to a maximum of 14.41 Mpa with a cement water ratio of 0.4. In this case, the compressive strength concrete using aggregates from Bangkalan has not yet reached a standard even for normal concrete. It is considered to fine aggregate granules are too smooth. The following research from Pertiwi and Choiriah [6] with the title Combination of Lumajang Sand and Bangkalan Sand Viewed from Normal Concrete compressive Strength. From the results of the study obtained concrete compressive strength with Lumajang sand composition 10% + 90% Bangkalan sand compressive strength 21.567 Mpa, Lumajang sand 20% + 80% Bangkalan sand 24.120 Mpa, Using Lumajang sand composition 10% - 20% and Bangkalan sand 80 -90% meets the specified compressive strength of 20 Mpa.

2.2. Additional Material

Types of chemical additives (Substances Additive) can be divided into 7 (Seven) types, namely:

1) Type A Water Reducing Admixtures are additional ingredients that function to reduce water in the mixture needed to produce betondengan certain consistency.
2) Type B Retarding Admixtures are additional materials that function to inhibit the binding time of concrete (setting time)
3) Type C Accelerating Admixtures are other materials that serve to accelerate the binding and development of the initial strength of concrete.

4) Type D Water Reducing and Retarding Admixtures are additional materials that have a dual function, namely reducing the amount of water in the mixture needed to produce concrete with absolute consistency and inhibiting the initial binding.
5) Type E Water Reducing and accelerating admixtures are additional materials that have a dual function, namely reducing the amount of water in the mixture needed to produce concrete with absolute consistency and accelerating the initial binding.
6) Type F Water Reducing, High Range Admixtures are additional materials that function to reduce the amount of water needed to produce concrete with a certain consistency, as much as 12% or more.
7) Type G Water is reducing, High Range Retarding Admixtures are additional materials that function to reduce the amount of water needed to produce concrete with a certain consistency, as much as 12% or more and also to inhibit the binding of concrete.

2.3. Concrete Compressive Strength

The concrete compressive strength depends on the cement water ratio. Also depending on compaction during execution, concrete compressive strength is determined by the results of differences in the standard of the cylinder (measuring 15 cm x 30 cm). Those treated under standard laboratory conditions at certain loading speeds (amounting to 6 - 4 kg / cm^2 per second) At the age of 28 days. In practice, there are three types of test objects, namely cubes with sizes 100 x 100 mm, 150 x 150 mm, cylinders 150 x 300 mm, 100 x 200 mm. In Standard British, it is permissible to use cylinders of 100 x 200 mm if the maximum diameter of coarse aggregate is 20 mm. The compressive strength of concrete is calculated using the equation:

$$fc' = \frac{P}{A} \text{ (Mpa)}$$

f'c= concrete compressive strength
P = Maximum load (N)
A = Area of the test specimen (mm2)
Types of chemical additives

3. Methodology

The research was carried out in the laboratory by conducting sludge content testing, sieving analysis, the specific gravity of sand and gravel wear, taken from Bangkalan Regency. To determine the compressive strength of concrete, cylindrical specimens of size 15 cm x 30 cm were used using a mixture with variations. 1. Fine aggregate and coarse aggregate size 5/10 and 10/20 from Bangkalan regency variation 2 Fine aggregates from Lumajang Regency and coarse aggregate size 5 / 10 and 10/20 from Bangkalan Regency on concrete mix. Variation 3 Fine aggregate from Lumajang Regency and coarse aggregate size 5/10 and 10/20 from Bangkalan Regency plus additive type D substance on concrete mixture. Variation 4 Fine aggregate from Lumajang Regency and coarse aggregate size 5/10 and 10/20 from Regency Bangkalan in concrete mix plus additive type F. Variation 5. Fine aggregate from Lumajang Regency and coarse aggregate size 5/10 and 10/20 from Bangkalan Regency plus additive type D and F. To determine the compressive strength of concrete, concrete compressive strength was tested at 7, 14 and 28 days.

4. Result and Discussion

4.1. Aggregate physical analysis

Table 1 Physical Test Results of Lumajang Sand

No	Experiment	Lumajang Sand	ASTM	Information
a	Moisture level	1,50%	1 - 5%	Satisfied
b	Specific gravity	2,70 gr/cm^3	1,60 – 3,30 gr/cm^3	Satisfied
c	Infiltration water level	2,36%	1% - 5%	Satisfied
d	Volume weight (Loose)	1,45 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
e	Volume weight (dense)	1,56 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
f	Filler content	2,5 %	Maks 5%	Satisfied
g	Organic content	No.3	No.3	Satisfied
h	Gradation design analysis	Zone 2 (Fm = 2,37)	2,0 < Fm <3,1	Satisfied

Table 2 Physical Test Results of Bangkalan Sand

No	Experiment	Lumajang Sand	ASTM	Information
a	Moisture level	9,40%	1 - 5%	Not Satisfied
b	Specific gravity	1,67 gr/cm^3	1,60 – 3,30 gr/cm^3	Satisfied
c	Infiltration water level	4,43%	1% - 5%	Satisfied
d	Volume weight (Loose)	1,06 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
e	Volume weight (dense)	1,18 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
f	Filler content	22,3 %	Maks 5%	Not Satisfied
g	Organic content	No.3	No.3	Satisfied
h	Gradation design analysis	Zone 1 (Fm = 3,99)	2,0 < Fm <3,1	Not Satisfied

Table 3 Physical Test Results for 10-20 Bangkalan Gravel

No	Experiment	Gravel 10-20	ASTM	Information
a	Moisture level	1,95%	1 - 5%	Satisfied
b	Specific gravity	2,97 gr/cm^3	1,60 – 3,20 gr/cm^3	Satisfied
c	Infiltration water level	1,06%	Max 4%	Satisfied
d	Volume weight (Loose)	1,32 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
e	Volume weight (dense)	1,54 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
f	Filler content	1,75 %	Maks 1%	Not Satisfied
g	Gradation design analysis	Fm = 7,97	6,5 < Fm <8,0	Satisfied

Table 4 Physical Test Results for 5-10 Bangkalan Gravel

No	Experiment	Gravel 5-10	ASTM	Information
a	Moisture level	1,05%	1 - 5%	Satisfied
b	Specific gravity	2,62 gr/cm^3	1,60 – 3,20 gr/cm^3	Satisfied
c	Infiltration water level	1,68%	Max 4%	Satisfied
d	Volume weight (Loose)	1,33 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
	Volume weight (dense)	1,54 kg/dm³	0,4 - 1,9 kg/dm³	Satisfied
e	Filler content	2,2 %	Maks 1%	Not Satisfied
f	Gradation design analysis	Fm = 5,74	4,0 < Fm < 6,0	Satisfied

4.2. Compression test analysis

The results of the calculation of concrete compressive strength can be seen in table 5 and figure 1.

Table 5 Comparison of Concrete Compressive Strength Various variations

Age (Day)	**Compression test (Mpa)**				
	NB	NL	D(0,3%)	F(0,6%)	D(0,3%)+F(0,6%)
7	8,84	16,74	24,48	19,90	22,95
14	9,23	20,55	27,24	23,47	22,96
28	13,08	21,90	29,44	27,45	25,53

Information

NB : Bangkalan sand with Bangkalan gravel presentation of 5/10 and 10/20
NL : Lumajang sand with Bangkalan gravel presentation of 5/10 and 10/20
D (0,3%) : Lumajang sand with Bangkalan gravel presentation of 5/10 and 10/20 + type D additive 0.3%
F (0,6%) : Lumajang sand with Bangkalan gravel presentation of 5/10 and 10/20 + type F additive 0.6%
D(0,3%)+F(0,6%) : Lumajang sand with Bangkalan gravel presentation of 5/10 and 10/20 + type D additive 0.3% and type F additive 0.6%

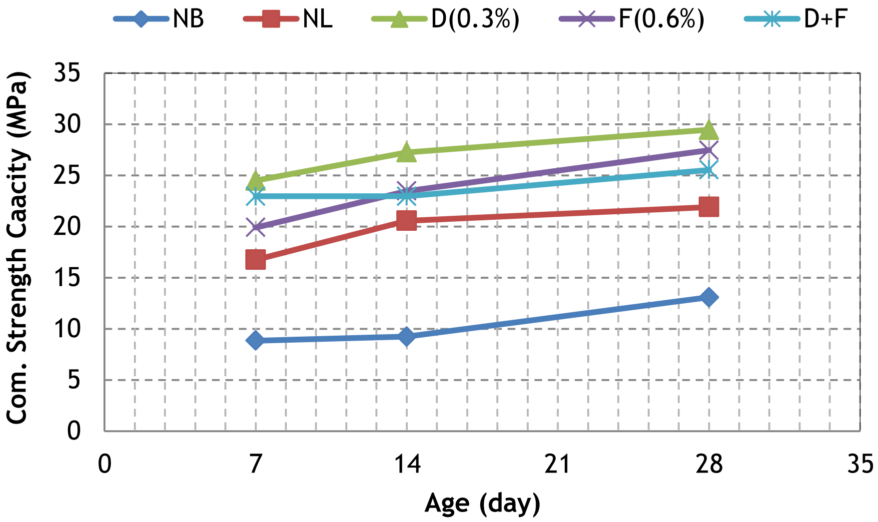

Figure 1. Compression test of concrete comparrison

From Figure 1 shows that the concrete using a mixture of fine aggregate and coarse aggregate from Bangkalan has the concrete compressive strength of 13.08 Mpa while the concrete mix using Lumajang fine aggregate and Bangkalan coarse aggregate has a compressive strength of 21.90 Mpa due to aggregate granules Halus Bangkalan is too smooth and contains high levels of sludge. By adding a type D additive of 0.3% to the concrete mixture using Lumajang fine aggregate and crude aggregate Bangkalan Concrete compressive strength to 29.44 MPa.

5. Conclusion

The results of the study can be concluded

1. Concrete compressive strength using fine aggregate and rough size 5/10 and 10/20 Bangkalan aggregates produce a compressive strength of 13.08 Mpa
2. Concrete compressive strength using Lumajang fine aggregate and coarse scale 5/10 and 10/20 Bangkalan aggregate produced a compressive strength of 21.90 Mpa.
3. Concrete compressive strength by using Lumajang fine aggregate and coarse aggregate size 5/10 and 10/20 Bangkalan plus 0.3% additive type D produce a compressive strength of 29.44 Mpa
4. The compressive strength of concrete using fine Lumajang aggregate and coarse aggregate size 5/10 and 10/20 Bangkalan plus additive type F 0.6% produce a compressive strength of 27.45 MPa
5. The compressive strength of concrete using fine Lumajang aggregate and coarse aggregate size 5/10 and 10/20 Bangkalan plus additive type D 0.3% and type F 0.6% produce a compressive strength of 25.53 MPa

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6. References

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