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Correlation of Concrete Quality to Water Seepage on Reinforced Concrete Slab Roofs

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Abstract
The quality of concrete is very dependent on the use of aggregates that we use in the concrete mix, and each aggregate that comes from nature has a different water absorption value depending on where the aggregate comes from and where it is located. If it is connected to the compressive strength of concrete, the greater the aggregate positivity number, the smaller the strength of the concrete and the greater the absorption capacity of the concrete to accommodate water in the concrete. The purpose of this research is to look for field problems where every concrete floor that functions as a roof and floor always causes problems, namely frequent leaks due to seepage of rainwater when it rains. From research on 3 types of concrete quality, it was found that K-175 kg/cm^2 produced a water absorption capacity of 2.77% and the value of the absorption test results for the quality of K-250 kg/cm^2 was 1.30% as well as the value of the results of the absorption test for the quality of K-300 kg/cm^2 was 0.69%. Then from the floor slab model with 3 types of concrete quality, it was obtained from the observation that the quality of the K-175 kg/cm^2 concrete could show seepage on the bottom surface of the floor slab model at the age of 2 days of soaking, but the floor slab model with concrete quality K- 250 kg/cm^2 and concrete quality K-300 kg/cm^2 there is no seepage. It can be concluded that the lower the quality of the concrete, the greater the water absorption capacity of the concrete and the greater the seepage of water into the concrete, and vice versa.

Keywords: *concrete slab, absorption, seepage, aggregate*

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I. INTRODUCTION

The quality of concrete is very dependent on the use of aggregates that we use in the concrete mix, and each aggregate that comes from nature has a different water absorption value depending on where the aggregate comes from and where it is located. If it is connected to the compressive strength of concrete, the greater the aggregate porosity number, the smaller the strength of the concrete and the greater the absorption capacity of the concrete to accommodate water in the concrete. The concrete floor slab that functions as a roof to withstand rainwater that enters the building space, the position of the concrete floor slab is at the top and outermost position so that the concrete floor slab construction is very vulnerable to the influence of outside weather, namely rain and heat. At this time building plans using concrete floor slabs as roofs have become buildings that are quite in demand, this is because the concrete floor slabs have multiple functions, namely functioning as a roof and can also be used as a parking lot in mall and hotel buildings, as well as being used as an open space for drying materials and many other functions. However, the use of the function of the concrete floor as a roof sometimes does not fulfill what we want due to the failure of the building due to the seepage of rainwater into the building.

West Kalimantan in general and Pontianak City in particular have a fairly high rainfall. The use of a concrete floor as a roof certainly has several problems, namely when it rains, leaks often occur through seepage on the concrete roof. This leakage gets worse as the concrete floor ages, an example of a concrete floor slab that has seepage is the Pontianak State Polytechnic building. Almost all of the concrete floor slabs are seeping and leaking. By looking at this incident, we as researchers want to find out the cause of the seeping of the concrete floor slab in the building and it is very interesting to observe and study.

The research we are doing is a case study, meaning that what happened in the field, we will find out what causes the concrete floor to fail to withstand rainwater seepage when it rains. Through this research, we try to open the veil to reveal the occurrence of leaks with seepage on the concrete floor slabs which are often the complaint of buildings around us. Our research is trying to examine the correlation between the quality of concrete or the compressive strength of concrete. We suspect at the initial diagnosis that the higher the compressive strength of the concrete, the smaller the porosity value and the smaller the absorption value of the concrete so that the leakage of the floor slab can be stopped. The goal to be achieved in this research is to find

out how much the value of the absorption from the use of each aggregate size. In addition, each model is also treated with its own work method so that it can affect the quality of the concrete produced.

1.1 Materials

The material used for the manufacture of the test objects from the location where sell crushed stone from Peniraman, sand from Ambawang River, and the cement is Tiga Roda brand.

1.2 Method

The tests carried out in the laboratory and workshop of the Civil Engineering Department are testing the quality of the fine aggregate, testing the quality of the coarse aggregate, testing cement adhesive, job mix design concrete, testing concrete cubes and concrete absorption and making models of concrete floor slab specimens and maintenance. Making absorption test objects from each concrete quality, namely; K-175 kg/cm^2, K-250 kg/cm^2, and K-300 kg/cm^2. The total number of test objects is 15 pieces. Make a test object model of reinforced concrete floor slabs with different variations of concrete, namely the floor slab model with concrete quality K-175 kg/cm^2, K-250 kg/cm^2, and K-300 kg/cm^2, analyze the test results and make conclusions so that it can provide information and references, especially in the world of education in the subject of concrete structures, material testing, concrete work and provide information to the construction industry. For more details, this research method can be seen in the flow chart below:

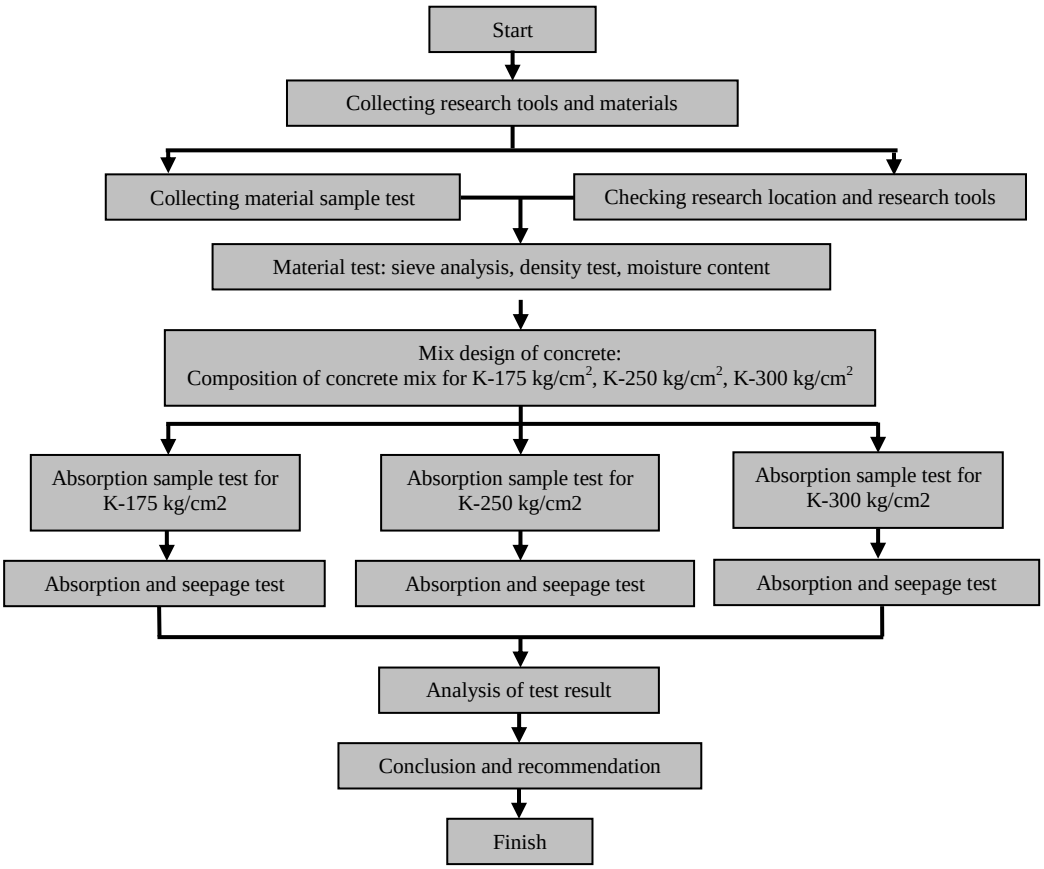

Figure 1: Research method

As for what is done in this research is the manufacture of job mix design concrete by obtaining the following data:

Table 1: Mixture composition per 1 sack of cement (50 kg) for concrete quality K-175 kg/cm^2

Material	Weight (kg)	Vol. weight	Vol. (l)	Vol. (cm^3)	Pouring Amount
Cement	50.00	1.25	40.00	1 sack	1
Sand	77.00	1.64	46.96	23.040	2.0
Coarse agg.	156.33	1.33	117.44	38.400	3.0
Water	27.26	1.00	27.26	cap. 5 l	5.5

From the results of testing the concrete cube K-175 kg/cm^2 aged 7 days, it is obtained:

$$\sigma'_{bm} = \sum_{1}^{n} \frac{\sigma'_b}{n} = 259.829\ kg/cm^2$$

$$SD = \sqrt{\sum_{1}^{n} \frac{(\sigma'_b - \sigma'_{bm})^2}{n-1}} = 16.888\ kg/cm^2$$

$$\sigma'_{bk} = \sigma'_{bm} - \frac{ti \times SD}{\sqrt{n}} = 245.937\ kg/cm^2$$

Table 2: Mixture composition per 1 sack of cement (50 kg) for concrete quality K-250 kg/cm^2

Material	Weight (kg)	Vol. weight	Vol. (l)	Vol. (cm^3)	Pouring Amount
Cement	50.00	1.25	40.00	1 sack	1
Sand	64.53	1.64	39.36	18.144	2.0
Coarse agg.	131.02	1.33	98.42	32.000	3.0
Water	23.70	1.00	23.70	cap. 5 l	4.7

From the results of testing the concrete cube K-250 kg/cm^2 aged 7 days, it is obtained:

$$\sigma'_{bm} = \sum_{1}^{n} \frac{\sigma'_b}{n} = 292.130\ kg/cm^2$$

$$SD = \sqrt{\sum_{1}^{n} \frac{(\sigma'_b - \sigma'_{bm})^2}{n-1}} = 14.941\ kg/cm^2$$

$$\sigma'_{bk} = \sigma'_{bm} - \frac{ti \times SD}{\sqrt{n}} = 280.017\ kg/cm^2$$

Table 3: Mixture composition per 1 sack of cement (50 kg) for concrete quality K-300 kg/cm^2

Material	Weight (kg)	Vol. weight	Vol. (l)	Vol. (cm^3)	Pouring Amount
Cement	50.00	1.25	40.00	1 sack	1
Sand	58.30	1.64	35.55	18.144	2.0
Coarse agg.	118.37	1.33	88.92	30240	3.0
Water	21.92	1.00	21.92	cap. 5 l	4.4

From the results of testing the concrete cube K-250 kg/cm^2 aged 7 days, it is obtained:

$$\sigma'_{bm} = \sum_{1}^{n} \frac{\sigma'_b}{n} = 346.349\ kg/cm^2$$

$$SD = \sqrt{\sum_{1}^{n} \frac{(\sigma'_b - \sigma'_{bm})^2}{n-1}} = 13.618\ kg/cm^2$$

$$\sigma'_{bk} = \sigma'_{bm} - \frac{ti \times SD}{\sqrt{n}} = 335.236\ kg/cm^2$$

The conclusion from the concrete cube test for the job mix design formula that has been designed for compressive strength has been reached. For the next step, the research is continued on the manufacture of water absorption test objects by concrete.

1.3 Making Concrete Water Absorption Sample Test

The number of test sample made was 15 pieces with the size 5 cm x 5 cm x 5 cm. Manufacturing is done by making formwork first, formwork using 9 mm thick multiplex board.

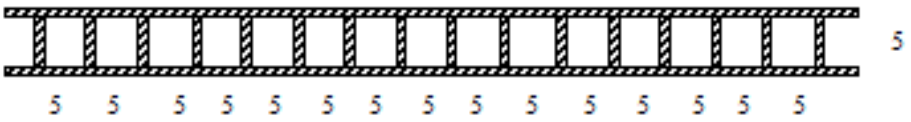

Figure 2: Formwork of concrete water absorption

Figure 3: Manufacture of water absorption test sample completed within conditioning

The formwork of the test sample model for the floor slab made using multiplex boards with a size of 66 cm long, 66 cm wide and 8 cm thick. The floor slab formwork is made to hang, adjusting as made in the field where the formwork is installed with scaffolding. Formwork like this is made 3 pieces of the same size

Manufacture of reinforcement for floor slabs using 8 mm diameter with a distance of 150 mm. This floor slab reinforcement assembly is made exactly the same as in field conditions.

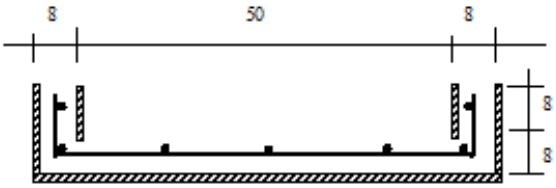

Figure 4: Reinforcement of floor slab

Figure 5: Assembly of reinforcement and formwork

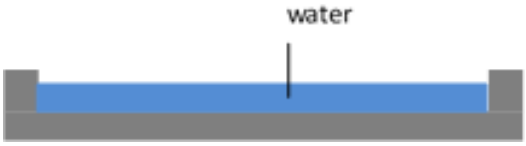

Figure 6: Floor slab model test sample

Concrete curing is carried out at the age of 1 day by covering the concrete surface using plastic, days 2 and 3 watering the concrete surface. On the fourth day and so on, conditioning is carried out by placing the test sample model in the open air for 30 days. After the concrete reaches sufficient age, the permeability of the concrete is tested against water

In this study, 3 types of test sample were made, including concrete mix design, namely the quality of K-175 kg/cm^2, K-250 kg/cm^2, K-300 kg/cm^2, with a concrete cube test objects of 5 pieces each, with a size of 15 cm x 15cm x 15cm. And then the researchers made 3 kinds of absorption test sample, namely; quality of concrete K-175 kg/cm^2, K-250 kg/cm^2, and K-300 kg/cm^2 with the number of concrete absorption test sample of 5 pieces each, with a test object size of 5 cm x 5 cm x 5 cm. Then the researchers also made 3 kinds of test models for reinforced concrete floor slabs, namely; concrete quality K-175 kg/cm2, K-250 kg/cm2, and K-300 kg/cm2 with the number of each test sample for the concrete floor slab model as much as 1 piece, with sizes as shown in figure 4.

II. RESULT AND DISCUSSION

After making the test sample, the next job is to measure or test. The test is carried out in the Civil Engineering Department materials laboratory with the following data:

Table 4: Concrete compressive strength test result

Conc. Qua.	No. sample	Age	Area (cm^2)	Conc. comp. strength (28 days)	σ'_{bk} (kg/cm^2)
K-175	175-1	7	225	270.09	245.937
	175-2	7	225	259.83	
	175-3	7	225	252.99	
	175-4	7	225	239.32	
	175-5	7	225	287.18	
	175-6	7	225	249.57	
K-250	250-1	7	225	300.85	280.017
	250-2	7	225	297.44	
	250-3	7	225	280.34	
	250-4	7	225	314.53	
	250-5	7	225	287.18	
	250-6	7	225	273.50	
K-300	300-1	7	225	335.04	335.236
	300-2	7	225	358.97	
	300-3	7	225	341.88	
	300-4	7	225	328.21	
	300-5	7	225	362.39	
	300-6	7	225	352.14	

Table 5: Concrete absorption test result

Con. Qua.	No. Sample	Dry weight Normal (gr)	Dry weight SSD (gr)	Absoprtion (%)	Absorption average (%)
K-175	1	301.32	309.66	2.7678	2.77
	2	283.77	291.35	2.6712	
	3	296.02	304.35	2.8140	
	4	294.55	302.85	2.8179	
	5	302.118	310.56	2.7943	
K-250	1	294.68	299.23	1.5440	1.30
	2	293.95	298.57	1.5717	
	3	295.55	300.18	1.5666	
	4	296.95	298.52	0.5287	
	5	295.22	299.07	1.3041	
K-300	1	293.31	294.89	0.5387	0.69
	2	291.13	294.74	1.2400	
	3	290.84	293.41	0.8836	
	4	291.09	292.49	0.4810	
	5	289.06	290.01	0.3287	

Testing of seepage of concrete floor slabs against rainwater is carried out by observing in the field. After the concrete floor slab model is completed, the concrete treatment is carried out for 3 days where the model is stored in a place free from rain and sunlight. On the 4th day, the concrete floor slabs stored in the open place with the aim of conditioning to approach the treatment of floor slabs in the field that received hot and rainy weather for 30 days. After that, fill the water on the floor slab and observe whether there is seepage from each model made from each type of floor slab. Observations were made starting from the first day when water was added. The result is as follows:

Table 6: Seepage observation result

Con. Qua.	No. Sample	Days	Observation
K-175	1	2	It seems seeping on the 2nd day, the bottom floor looks wet
K-250	1	-	No seepage, under the floor slab looks dry
K-300	1	-	No seepage, under the floor slab looks dry

The analysis of the research results was obtained from the results of testing materials in the materials laboratory of the Department of Civil Engineering and from observations. The results of the test are carried out on the absorption value of concrete from each test sample and from each concrete quality. The seepage value of the floor slab is taken from the observation value of 3 different floor slab models of each concrete quality. From the absorption value of concrete, it turns out that the lower quality concrete has the greater absorption value, for example the quality of concrete K-175 kg/cm^2 the average absorption value is 2.77%, the quality of K-250 kg/cm^2 concrete has an absorption value of 1.30% and the quality of concrete K-300 kg/cm^2 absorption value is 0.69%.

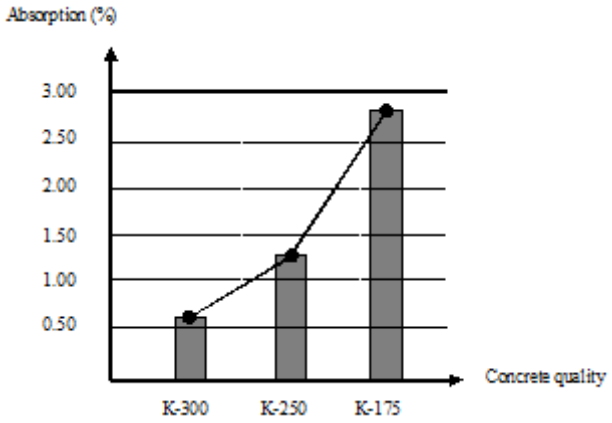

Figure 7: Water absorption of concrete vs concrete quality

Table 7: Observation of RC floor slab seepage

No. Sample	Concrete quality	Observation result	Description
1	K-175	Seepage occurs	Seepage occurred on the 2nd day of observation, seepage was not in the form of droplets but in the form of a black cloud image at the bottom of the floor slab. The picture of the seepage on the 3rd day and so on is getting wider. It is possible that the capillary tube will widen, this will make the picture of water seepage wider.
2	K-250	Seepage not occurs	It was observed on day 2, 3, and day 30 that no seepage occurred. We do not observe above the 30th day.
3	K-300	Seepage not occurs	It was observed on day 2, 3, and day 30 that no seepage occurred. We do not observe above the 30th day.

III. CONCLUSION

Based on the design of the concrete job mix formula and the results of the concrete cube test, the following results were obtained: the quality of concrete K-175 obtained an average compressive strength of 245,937 kg/cm^2, the quality of concrete K-250 obtained an average compressive strength of concrete an average of 280,017 kg/cm^2, and the quality of concrete K-300 obtained an average concrete compressive strength of 335,236 kg/cm^2.

The results of the absorption test of each concrete quality are as follows: the water absorption value of K-175 concrete is 2.77% and the water absorption value of K-250 concrete is 1.30%, and the water absorption value of K-300 concrete is 0.69 %.

The results of the seepage test on the reinforced concrete floor slab model are as follows: water seepage on the concrete floor slab of K-175 concrete quality can occur. Seepage began to occur on the second and third

day where the following day seepage was getting wider. Seepage of water is not a drop but seepage in the form of a shadow at the bottom of the reinforced concrete floor slab. Seepage is not visible on the floor slab with concrete quality K-250, and concrete with quality K-300.

From the test value on the quality of concrete, water absorption and seepage of the concrete floor slab, then: the lower the quality of the concrete, the greater the value of water absorption in the concrete. And vice versa, the higher the quality of the concrete, the smaller the value of water absorption in the concrete. It is proven that the lower the concrete values, the higher the seepage value of the concrete.

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