

## The Application of Molasses as Adding Materials to Increase the Compressive Strength of Concrete

Marwahyudi<sup>1</sup>, Arif Yulianto<sup>2</sup>, Musta'an<sup>3</sup>, Rahmat Wisudawanto<sup>3</sup>

<sup>1</sup>Interior Design Department, Sahid Surakarta University (USS), Surakarta, Indonesia

<sup>2</sup>Visual Design Communication Department, Sahid Surakarta University (USS), Surakarta, Indonesia

<sup>3</sup>Communication Department, Sahid Surakarta University (USS), Surakarta, Indonesia

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**Abstract:** Sugar factory waste is quite interesting for analysis. Waste which is resulted in the form of solid, gas, liquid still requires a further process. The objective of the research is to analyze molasses as the adding materials for concrete. In this study, it involved two groups of specimens that would be compared one to the other. Then, the compressive strength of the specimen is calculated by using compression test and hammer test machines. The analysis result showed that the concrete with molasses would be better than common concrete. The calculation result shows that the highest compressive strength of concrete with molasses is 123.8 kg/cm<sup>2</sup> while the highest common concrete is 106.2 kg/cm<sup>2</sup>. Moreover, the split calculation is 15.6 kg/cm<sup>2</sup> without molasses and 26.1 kg/cm<sup>2</sup> with molasses. Calculations of test hammer also shows that concrete with molasses has better performance. The results also concluded that the initial bond of concrete with molasses was a bit slow, so it should be careful when releasing the concrete mold. It also can be assumed that molasses can be used for adding materials in the wall. Therefore, it will reduce cracks in the walls.

**Keywords:** Molasses; Concrete compressive strength; Initial bonding concrete; Adding materials

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### 1 INTRODUCTION

Molasses is one of the waste products of the sugar factory. It is a remnant of crystallized sugar repeatedly and no longer possible to be processed into sugar with conventional processes. It is usually used for fertilizer, raw material of alcohol, and also substance for flavoring dishes.

The total product sugar factory of molasses is quite a lot, it is about 162 tons per year [1]. The market price of molasses is Rp. 10,000, - per liter. Thus, there is an abundance of molasses resulted by sugar factory. Many industries, however, only use the molasses which is in good quality while the bad quality rarely use. Moreover, there is no society who uses molasses to concrete mixture although molasses is possible to increase the compressive strength of concrete. In the Dutch colonial period, there was many building such as channels and dams often used molasses to increase adhesion strength and watertight. It is due to the fact that molasses has water reducing and retarding effect on concrete [2].

### 2 LITERATURE REVIEW

#### 2.1 The waste of sugar cane

The number of sugar factory in Indonesia at 2007 is about

59 factories. Sugarcane production in 2008 for the east Java reached 17 million tons. In producing sugar cane, it also produces waste and molasses. Molasses from sugar cane can be divided into 3 types [3]. Molasses class 1, class 2 and black strap. The first class molasses is obtained when we first crystallized cane juice.

Then molasses class 2 or commonly called the "Dark" is obtained when the second crystallization process is occurred. Brownish color that is often referred to as the "Dark". The final grade molasses, black strap derived from the final crystallization. This strap is black color approaching black (dark brown) so it was not wrong if it was given the name "Black Strap". Black strap appears to have a useful substance. These substances include calcium, magnesium, potassium, and iron.

#### 2.2 Concrete

Concrete is a mixture of several elements into a single unit that serves to hold the style press [4]. Those elements are cement, water and aggregate. Some of these elements function in accordance with their own functions. The main ingredient in the manufacture of concrete is cement [5].

In order to produce the optimum performance of concrete, it is necessary to know about cement. Cement will harden when it is exposed to water. If the cement has hardened it will not be able to function optimally [6].

In producing the concrete, it is needed some materials, such as cement, water, sand and brick. All material should be mixed together in order to form concrete. The mixture of water and cement results the cement paste, which serves as connective material. The cement used for the manufacture of concrete is finely grained cement. Cement which is containing small clump is not good for the manufacture of concrete [3]. Furthermore, the water which is used in producing the pasta cement must not contain oils, acids, alkalis, salts, organic materials or other materials that may damage the concrete [7]. Meanwhile, the other material of concrete is sand and brick. The quality of the sand used as an ingredient of concrete must be adequate with sharp grain and hard enough to withstand weather changes. It should not contain mud more than 5% of the dry weight. In additions, it must also not contain marine sand (except with the expert staff instructions), because it contains a lot of salt. Whereas, brick which is used as an ingredient of concrete has the characteristic such as dense, hard, clean and it must be neither porous nor contain more than 1% of mud. Once completed, pasta cement and agregate is mixed one another. In this case, sand and gravel aggregate is a material that serves as filler material as well as material bound by cement paste [8].

### 3 APPROACH AND METHODS

#### 3.1 Research Framework

In the first year of this study, the research tried to assume that molasses could actually increase the compressive

strength of concrete so it was needed to take the data research. The data analysis will be able to provide the information correctly. Therefore, it would not be wrong in the process, decision, analysis and conclusion of research. Finally, this research would be successful, true and reliable [9].

Compressive strength of concrete which is added molasses would be compared to concrete without molasses. Based on the analysis, some conclusions will be drawn. In the calculations, it would be necessary to take sample and need to calculate by means of formula as given by the literature [10].

Specimens are made in the form of cylinder and grouped into two. First, specimens without molasses was mixed with cement, sand and gravel. Second, a specimen with molasses was mixed with cement, sand and gravel. Concrete is made by mixing manually. It intends to determine the strength will be more similiar to what the common concrete. Then, the compressive strength is studied. Finally, the results were compared between the concrete with molasses and without molasses. Compressive strength investigation was taken by a hammer test and compression test machine.

In order to run the study well and smoothly, it is necessary to design the experiment carefully. The design is in the form research stages to be carried out [11]. A stage is a step in the work of the research so it would result in research benefits in line with expectations.

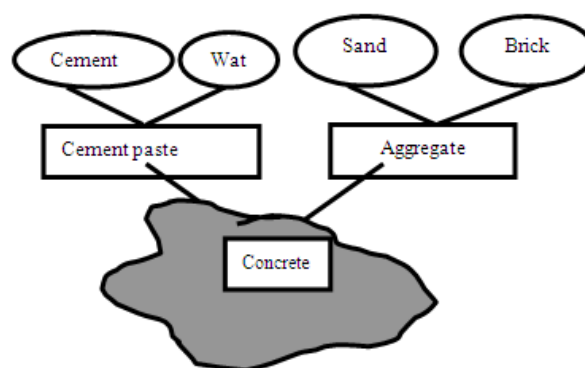


Figure 1: Concrete Structure

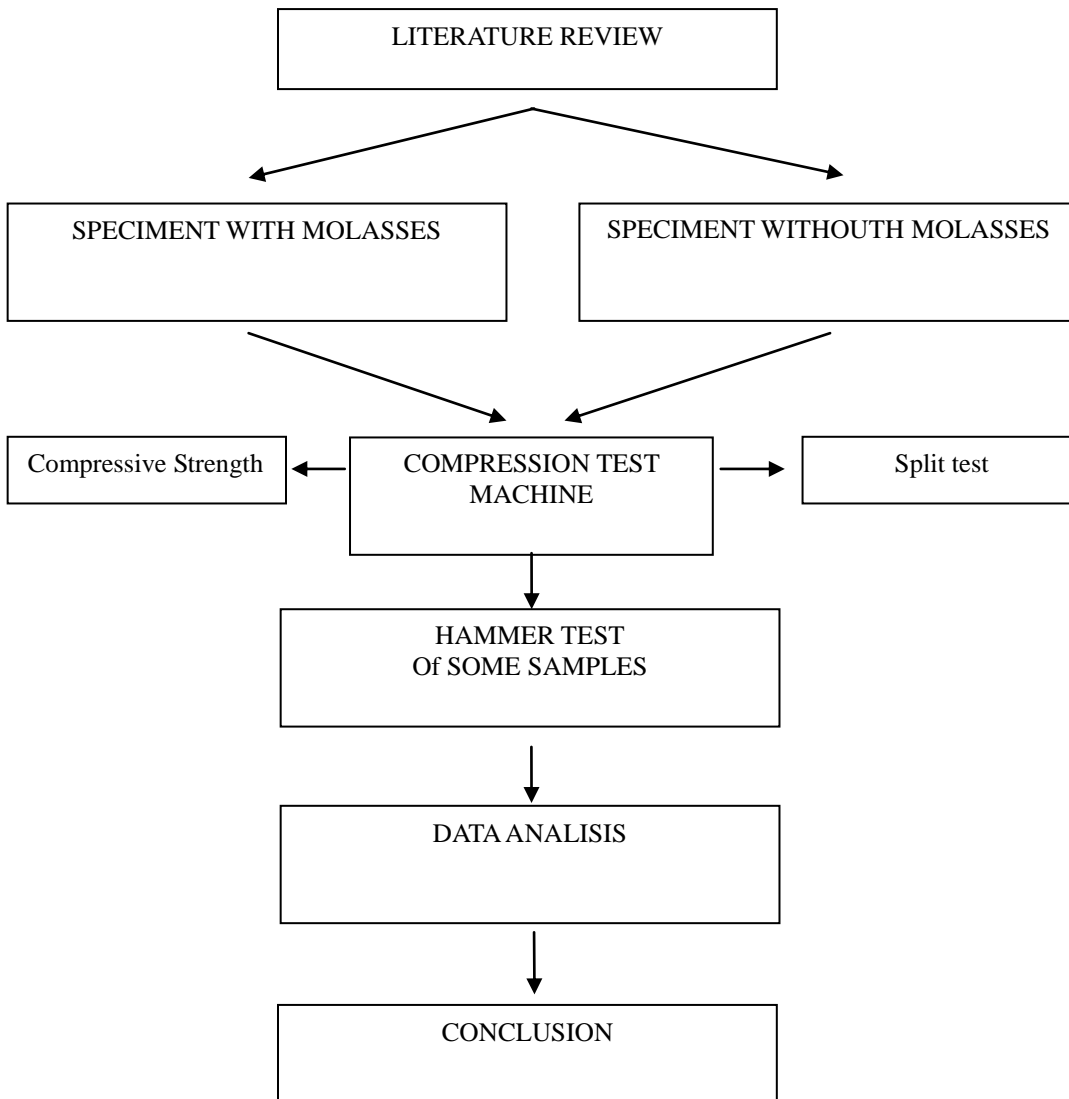


Figure 2: Research Framework.

## 4 RESULTS AND DISCUSSION

### 4.1 Results

#### 4.1.1. Normality Assay

The calculation of compressive strength of concrete in this study uses two tools, i.e. hammer test and compression test machine. Both of them will function to complementary one each other. It is taken due to the caution in analyzing the data. Therefore, it hopes the results of the analysis can be justified.

In the calculation of the compressive strength using Hammer test [10] data compression strength of concrete

was found as normal distribution. Thus, it needs for normality and homogeneous assay to ensure that the data are normally distributed.

The formula of normality and homogeneous assay is [7]:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-1/2(x-\mu)^2} \quad (1)$$

It will be normal distributed if the results is -1 to 1 (-1 < x < 1), where as :

- $\sigma$  = deviation standard
- $\pi$  = 3.1416
- $e$  = 2.7183
- $\mu$  = Mean

If the formula above cannot be calculated, so a graphical method will be used. As the horizontal axis is less than the data and the vertical axis is the frequency of data in percent. If the data is connected one each other, it will make a straight line, then it can be considered as normal distribution data.

#### 4.1.2. Normality and Homogeneous Assay

If the value of the mean, median and mode are equal or close to equal, then the data can be considered as homogeneous. Meanwhile, in calculating the compressive strength by means of compression test machine, it should be noted to the units on the instrument measurement. Basically, the calculation of the compressive strength is the result of measurement in equipment divided by dimensional area of the specimen.

The results of the compressive strength test with a compression test machine shows that concrete with molasses related to the laboratory test has a higher compressive strength than concrete without molasses. Meanwhile, the calculation of results is as shown in Table 1.

Based on the data in Table 1, it can be seen that the compressive strength of concrete with molasses is bigger than the compressive strength of concrete without

molasses. Although in the datum number 1 has not shown that the specimen with molasses is more strength than specimen without molasses but after 28 days, the compressive strength test shows that specimen with molasses has higher strength. It also occurred in data number 3. Data number 4 and 5, however, shows the significantly differences. In datum number 4 the differences of the compressive strength test can be achieved more than 30 kg/cm<sup>2</sup> and the datum number 5 has the differences of 22,18 kg/cm<sup>2</sup>. It is supported that molasses has the adhering characteristic so that it makes the concrete stronger.

Similar to Table 1, Table 2 also shows that the specimen with molasses has the bigger split strength than the specimen without molasses. It is due to the fact that molasses has adhering characteristics. Therefore, concrete with molasses will be stronger than concrete without molasses. It can be seen in the explanation of the data below. After 40 days, the differences of specimen with and without molasses were measured by the split strength test only showed not more than 10 kg/cm<sup>2</sup>. Whereas, after 47 days, the differences achieved more than 10 kg/cm<sup>2</sup> as explained in the datum number 2, even in datum number 3 or after 63 days. There is a significant difference of split strength test that is shown by the specimen with and without molasses. The difference is of more than 18 kg/cm<sup>2</sup>.

*Table 1: The results of the compressive strength test with a compression test machine.*

Number	Days	Mean		Information
		With molasses	Without molasses	
1	7	3.25	30.5	Stronger without molasses
2	28	51.38	41.7	Stronger using molasses
3	40	66.35	59.8	Stronger using molasses
4	47	106.15	70.36	Stronger using molasses
5	59	110.58	88.46	Stronger using molasses

*Table 2: The results of the split strength test with a compression test machine*

Number	Days	Mean		Information
		With molasses	Without molasses	
1	40	20.83	12.15	Stronger using molasses
2	47	26.04	13.23	Stronger using molasses
3	59	28.51	15.11	Stronger using molasses
4	63	33.71	15.63	Stronger using molasses

*Table 3: The results of the compressive strength in laboratory test with hammer test.*

Number	Hammer Test data		Information
	With molasses	Without molasses	
1	27	20.5	More strength with molasses
2	22	24	More strength without molasses
3	20	27	More strength without molasses
4	23	18.5	More strength with molasses
5	23	15	More strength with molasses
6	20	17	More strength with molasses
7	26	18	More strength with molasses
8	19	19	Equal
9	20	18	More strength without molasses
10	23	15	More strength without molasses

*Table 4: Observation result*

Observation	Common concrete	Concrete + molasses
Color	Grey	Slightly yellowish
Early bond	Fast	Slow
Harshness	1 day	More than 1 day
Mold	Open in 1 day	Open in 5-7 days
C <sub>2</sub> S with C <sub>3</sub> S	Assumed C <sub>2</sub> S < C <sub>3</sub> S	Assumed C <sub>2</sub> S > C <sub>3</sub> S

Table 3 is the results of the compressive strength in laboratory test with *Hammer Test*. Based on 10 groups of data that tested by using hammer test, it shows that specimen with molasses is more dominantly strength than specimen without using molasses. Data number 1,4,5,6 and 7 are the groups data that shows the specimen with molasses is more strength. Meanwhile, data number 2, 3, 9 and 10 are groups the data that shows the specimen without molasses is more strength. However, there is also one datum that shows the similar strength of specimen with or without molasses. Therefore, it can be concluded that the split strength of concrete with molasses is bigger than the compressive strength of concrete without molasses. Once again, the adhering characteristics of molasses have effect to the results.

Based on the observation result in Table 4, it can be seen that there are differences characteristic from common concrete and concrete with molasses. As shown in Table 4, concrete with molasses is brighter and slightly yellowish. Meanwhile, common concrete has grey color. Related to the early bond, common concrete is faster than concrete with molasses. Meanwhile, the harshness and mold, common concrete better than concrete with molasses. The harshness of common concrete is one day and the mold

can be also opened in one day. For concrete with molasses, the harshness is more than one day and the mold can be opened in 5-7 days. Concrete with molasses consist of more C<sub>2</sub>S so the concrete is suitable for constructions in water area. Therefore, it is assumed that in making wall, it would be beneficial by adding molasses. It is due to the fact that by using molasses the initial bond will be slow.

#### 4.2 Discussion

The measurement of compressive strength and split strength of specimen is hold after 28 days. It is due to the fact that in creating the first sample with adding molasses as ingredients is unsuccessful. The unsuccessfulness is found in the opening of the cylinder mold after one day. Based on the results, it can be concluded that concrete with molasses requires longer time for drying process compared to ordinary concrete. Hence, the opening of the mold needs more time. It is suggested to open the mold after a week. The assumption of one week is to anticipate the sample specimen will not be damaged as in creating of the first specimen. For specimens without molasses, however, the opening of mold is after one day. Based on the schedule that had been planned, the compressive

strength test and split strength test of specimens were taken. The compressive strength test and split test were done to find out compressive and attractive force strength prediction of the concrete. Therefore it can be used for the development of further research. The result obtained from testing laboratory is calculated to know the concrete strength. Then, the result strength of concrete with molasses and concrete without molasses were compared. The result of the measure instrument is still calculated to determine the compressive strength and split strength related to the unit.

## 5. CONCLUSION

The following conclusions can be drawn from the experiments:

1. Concrete with molasses has a higher compressive strength and split strength compared to concrete without molasses.
2. The higher compressive strength is indicated in the calculation of the compressive strength of concrete with a hammer test.
3. Concrete with molasses has slow initial bonding with yellowish color.
4. It is recommended to open the mold in 5-7 days when using concrete with molasses.
5. It is assumed that the concrete with molasses consist more  $C_2S$  so the concrete is suitable for the construction in water area.
6. It is assumed that in making wall, it would be beneficial by adding molasses. It is due to the fact that by using molasses the initial bond will be slow.
7. The socialization to the society related to utilization of molasses as the adding material in making concrete with cheaper price and good quality are encouraged.

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