

# The influence of crystalline to compressive strength of concrete in terms of mixing methods and mixer speed

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**Abstract.** The problems will arise for concrete structure submerged under water. The performance concrete will decrease in that concrete such as less compressive strength and permeability. It is needed additive material has a water resistance in concrete mixture. In this research, it proposed crystalline as an additive material. The composition crystalline in concrete mixture is 0.8% from the weight of cement. The concrete mix design as follow SNI 03-2834-2000 standard. The method of concrete mixing used manual tool and concrete mixer. The mixer speed is set in this research are 25, 35, and 50 rotation per minutes (rpm). The delayed of addition crystalline in concrete mixture also done to know the effect of compressive strength concrete. The compressive strength is attained by using manual method and concrete mixer for 25 rpm, it is increased about 5.8% from the control concrete. However, the compressive strength is decreased for the speed of concrete mixer in 35 rpm and 50 rpm. The other additional material such as fly ash poured in concrete with crystalline 0.8%, but it doesn't improve the compressive strength of concrete. The delayed crystalline poured in fresh concrete doesn't affect the compressive strength of concrete.

**Keywords:** concrete, crystalline material, compressive strength, rpm

## 1. Introduction

Concrete is a mixture of portland cement or other hydraulic cement, fine aggregate, coarse aggregate and water with or without additives. Various researches were conducted to obtain quality of concrete in terms of compressive strength and workability. The additives material used to improve performance of concrete material. For concrete structure which is submerged under water, additives needed in improving the performance of concrete. One of the waterproof materials that can be used is crystalline.

Based on the literature, the addition of crystalline material as an additive can also increase the strength of concrete and has a water resistance. However, there is a decrease of compressive strength when the concrete with crystalline materials are applied in construction in the field. It may be caused by mixing process which is not in accordance with the characteristic coarse aggregates, fine aggregate and cement according to standard. The decrease in compressive strength is inversely proportional to previous research where crystalline material can improve the compressive strength of concrete [1].



Therefore, this research would like to find the effect of concrete mixing process using crystalline material. The mixing process that will be done in this research is manual method and using concrete mixer. The method of concrete mixing used manual tool and concrete mixer. The speed of concrete mixer is set in this research are 25, 35, and 50 rotation per minutes (rpm). The delayed of addition crystalline in concrete mixture also done to know the effect of compressive strength of concrete.

## 2. Study Literature

### 2.1 Additive Material

Additive material used in concrete mixture is crystalline. It is an added material to improve permeability of concrete. The composition of crystalline consists of portland cement and various active chemicals. The recommended for proportion crystalline in concrete mixture is 1-1.5% by weight of cement. However, in uncertain conditions the proportion may be less than 0.8%.

Crystalline material can reduce the permeability of concrete and it has ability to water resistance. The permeability of concrete can be decreased by 16% when the usage of crystalline 2% of weight of cement [7]. The permeability also decreased in concrete using crystalline with a proportion of 0.5%, 1%, 1.5% [9]. Crystalline material as additive of concrete is used to improve the permeability of concrete and it also used in improving compressive strength of concrete [8]. The compressive strength of concrete increased is 4%-8% to normal concrete [8]. The compressive strength of concrete with crystalline has a value of 49.5 MPa, it increased about 10% than normal concrete (44.5 Mpa) [10]. Based on research from Dr. Farhad Nabavi (2002), the compressive strength of concrete is increased about 22% with crystalline 0.8% and fly ash 25% as addition in concrete mixture [3]. However, the usage of crystalline can decreased the compressive strength of concrete and increased the permeability of the concrete itself [9]. Therefore, further research is needed to know the effect of crystalline to the compressive strength of concrete.

### 2.2 Mixing Methods of Concrete

Generally, the mixing process of concrete used manual method and mixer concrete. In concrete mixture process in manually done by a simple tool and human power. The mixer concrete is a common tool which is used in mixing concrete. The power from electricity needed to run mixer concrete and it help user in doing mixing concrete. These manual methods or mixer concrete had influenced to compressive strength of concrete [6].

The manual method used tools such as shovels, hoes, or other tools. The process mixing should be done in a flat media and located which has water-resistant. The initial step is poured cement and fine aggregate until both materials homogeneous. The next step is added coarse aggregate in concrete mixture. And then is poured water to concrete mixture until all materials evenly mixed. The manual mix design concrete refers to SNI 2493: 2011 [11].

The other method usually used mixer concrete. The whole materials poured in mixer concrete and it is run by rotating mixer concrete with certain duration or until the concrete homogenous. From the result, it can be concluded that the mixing using concrete mixer can increase the compressive strength of concrete up to 64,72% to manual method [6]. The sequence of materials concrete into concrete mixer also need to be arranged. According to SNI 2493: 2011, the initial sequence of concrete mixing is put in coarse aggregates and some water and additives, after that put in fine aggregate and cement to mixer concrete. The maximum time of pouring of cement, fine aggregate, coarse aggregate and water in mixer concrete is 11 minutes 28 second with total rotation of 180.48 times. It obtained the compressive strength of concrete is 30.01 Mpa or increased 33.8% from the mix design plan [12].

The time of mixing with longer time does not affect the result of compressive strength of concrete, and the faster rotation of mixer concrete does not mean the compressive strength is decreased. The normal rotation and cycle time of concrete mixer commonly used is 13 minutes 63 seconds and 218.08

times cycle. However, the addition of additive or admixture is needed in a special treatment to attain a homogeneous concrete mixture.

### 2.3 Influence of Mixing Time

The time of process mixing concrete is less consider by concrete mix design planner. there are many factors that can affect the quality of concrete, such as the workability and the curing of fresh concrete. The process of mixing concrete for certain volume as follow less or equal to 2 m<sup>3</sup> - 1½ minutes, 2½ m<sup>3</sup> - 2 minutes, 3 m<sup>3</sup> - 2½ minutes, 5 m<sup>3</sup> - 3 minutes. Similarly, the process of mixing concrete should be done not less than 1.5 minutes for 1 m<sup>3</sup> of mortar [13]. The process of mixing concrete must continue minimum in 1.5 minutes after all materials into mixer concrete. The time of mixing concrete shall be added ½ minutes for 1 m<sup>3</sup> of mortar capacity. The duration of time mixing not be too short, it will cause the concrete mixture is not unhomogenous yet. The process of mixing not be too long because it will reduce the compressive strength of concrete. The duration of time mixing concrete has a long periode affects the slump of the concrete itself [5]. There is an affect of duration time of mixing to compressive strength of concrete. The results obtained the maximum time of mixing is 2 minutes for the testing in 28 days [2].

### 2.4 The effect of speed of concrete mixer

The speed of concrete mixer depends on the type concrete mixer itself. There are two types of mixers that are differentiated by rotation axis orientation, are horizontal (drum mixer) and vertical (pan mixer) [14]. The drum mixer has a drum with a blade that keeps rotating around its axis, while the mixer pan has a blade that rotates around the axis. The mixer truck included the drum mixer category, where the truck mixer driver can control the rotation speed of the drum mixer inside the cabin. Usually the speed for mixing is 1.57 rad/s or equivalent to 15 rotation perminute. While the transport of pre-mixed concrete used only 0.2 rad/s (2 rpm) to 0.6 rad/s (6 rpm). The efficiency of the concrete mixer is determined by the homogeneity of the concrete produced. This homogeneity is measured by concrete composition or by variations of compressive strength and workability [14]. It means that the speed of concrete mixer rotation affects the compressive strength of concrete.

### 2.5 Compressive strength

The compressive strength of concrete design had to compliant with the compressive strength in 28 days of testing. The concrete properties are attained when the testing of compressive strength in laboratory is equal or more than design. The compressive strength of concrete is the ratio of the load to the cross-sectional area of concrete. The formula can be written as follows:

$$f_c = \frac{P}{A} \quad (2.1)$$

## 3. Methodology

The methodology of research can be seen in the table 1

**Table 1.** The Process mixing of concrete mixture

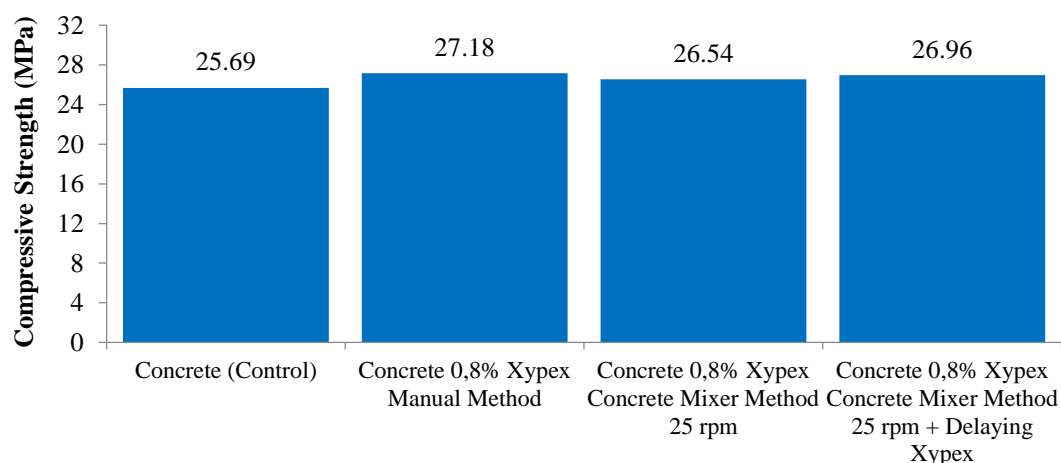
Manual (SNI 2493:2011)	Concrete mixer (SNI 2493:2011)	Concrete mixer + delayed poured of crystalline
Put in cement and additives material is not dissolved in water, fine aggregate. Mixed both of that materials until homogenous, then added coarse aggregates and mixed	Put in coarse aggregate for 5 minutes Added 2/3 of water and crystalline, the duration of mixer for 2 minutes	Put in coarse aggregate for 5 minutes Added 2/3 of water, the duration of mixer for 2 minutes

it, the next step is added water and admixtures	Poured fine aggregate + cement + 1/3 of water, the duration of mixer for 3 minutes	Poured fine aggregate + cement + 1/3 of water, the duration of mixer for 3 minutes
	And then rotate the mixer for 2 minutes until concrete setting	Added crystalline and then rotate the mixer for 2 minutes until concrete setting

#### 4. Results and Discussion

##### 4.1 The Effect of Xypex on Compressive Strength with Xypex C-1000 NF

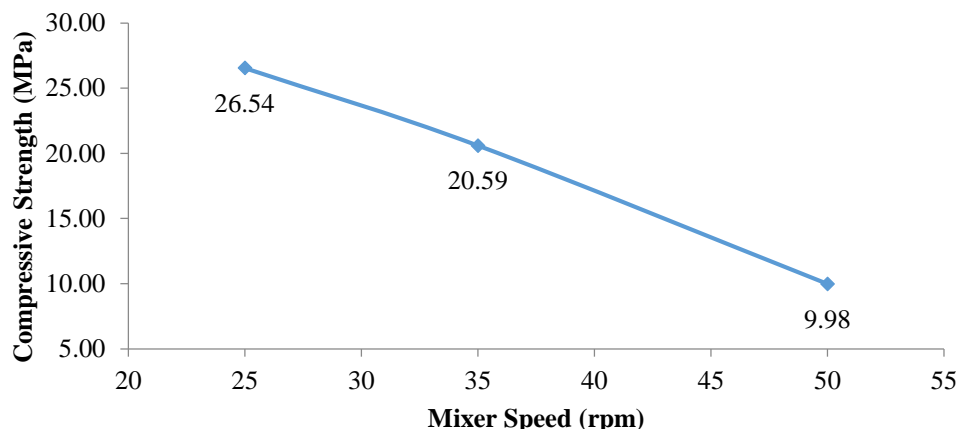
In Figure 1 shown the effect of the addition of crystalline (Xypex C-1000 NF) to compressive strength of concrete in several methods of mixing. Those methods are manual method, concrete mixer with 25 rpm, and concrete mixer with 25 rpm in delaying of poured crystalline in concrete mixture. It can be seen in Figure 1, the concrete with the crystalline can increase the value of compressive strength. The manual method obtained compressive strength is 27.18 MPa or 5.8% greater than the control concrete. In the concrete mixer method, crystalline can increase concrete up to 26.54 MPa or 3.3% larger than control concrete. For the mixing with concrete mixer with 25 rpm obtained compressive strength is 26.96 MPa or 4.9% greater than the control concrete. These results are approaching with the research by Munn, R., et al. (2002), where the addition of additives have function to reduce permeability and it can increase the compressive strength of concrete 4% to 8%. In this study, the maximum of compressive strength of concrete was found by concrete with crystalline without the addition of fly ash by using manual method [15].



**Figure 1.** The Effect of crystalline to compressive strength of concrete

#### 4.2 The Effect of Speed of Concrete Mixer on Compressive Strength with Crystalline

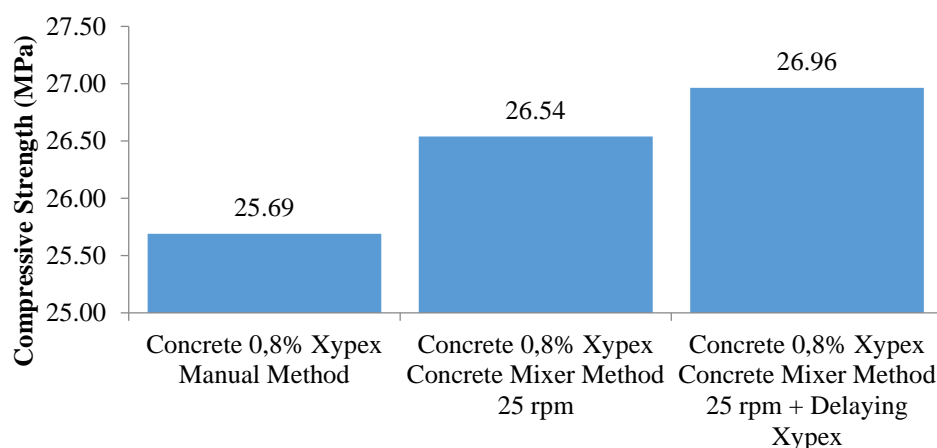
In Figure 2 presented the compressive strength of concrete with the addition of crystalline with the concrete mixer method with a rotation speed of 25, 35 and 50 rpm. The rotation speed of concrete mixer is generally 25 rpm, it means in one minutes occurs is 25 times rotation. In Figure 3, it can be seen that the speed of concrete mixer will decrease the compressive strength of concrete. The compressive strength of concrete is attained when the concrete mixer in 25 rpm. When the added of speed of concrete mixer to 35 and 50 rpm, the compressive strength are decreased.



**Figure 2.** The Influence of speed of concrete mixer to compressive strength concrete with crystalline

#### 4.3 The Effect of Concrete Mixing Methods with Xypex C-1000 NF

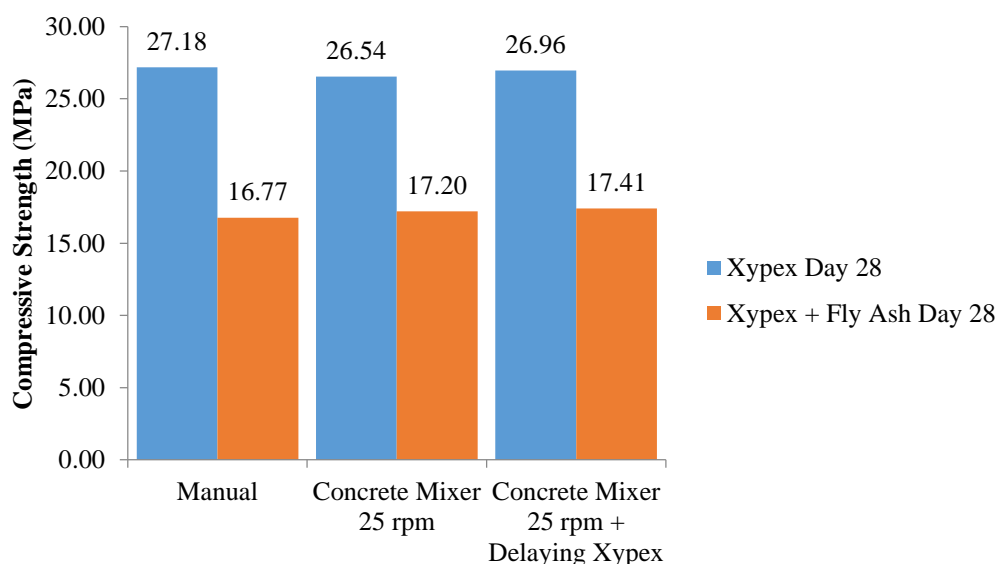
In Figure 3 is presented the value of the influence of the mixing method by manual method and concrete mixer. The compressive strength of concrete with crystalline used concrete mixer in 25 rpm is 26.54 MPa or increased by 3.3% to control concrete. For the delayed of pouring of crystalline in concrete mixture, the compressive strength is 26.96 MPa or 4.9% larger than the control concrete. Based on these results, it can be proposed that the delaying of crystalline in concrete mixture can be applied for concrete structure. The delayed addition time of material additive up to 10 minutes will increase the compressive strength and and decrease in the porosity of the concrete [4].



**Figure 3.** The Influence of mixing methods to compressive strength of concrete

#### 4.4 The Effect of Fly Ash to Concrete with Crystalline

In Figure 4, the value of the compressive strength of concrete mixed with crystalline and fly ash had been presented in several methods. It has decreased for concrete mixed with crystalline for all mixing methods. In the manual method, the compressive strength is less than 38.3%, than concrete mixed with crystalline. The decreased occurred as well in using concrete mixer, with the compressive strength reduced is 35.2%.



**Figure 4.** The effect fly ash to compressive strength of concrete with crystalline

## 5. Conclusion

Based on the results of research conducted several conclusions that can be drawn:

- The addition of crystalline with a percentage of 0.8% of the weight of cement in the concrete mixture can increase the compressive strength of concrete about 3.3-5.8% to normal concrete.
- The speed of mixer concrete proposed for concrete mixed with crystalline is 25 rpm.
- The delaying of poured crystalline in concrete mixture does not affect the compressive strength of concrete.
- The other admixture is fly ash caused a decrease of compressive strength of concrete with crystalline.

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