THE PERFORMANCE OF SUGAR BASED ADMIXTURE FOR CONCRETE AND MORTAR WITH AGE BEYOND 28 DAYS -POTENTIAL LOCAL ADMIXTURE FOR INNOVATIVE CONCRETE TECHNOLOGY-

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Abstarct
The development of concrete admixture goes along the development of concrete technology. It is understood that the need of admixture is to impart considerable physical and economic benefits with respect to concrete. Previous researches concluded that sugar based admixturessuch as sucrose, sugar, sugar cane liquid, perform as accelerator and retarder with dosages of 0.03% and 0.3% by weight of cement. This research wants to know the performance of sugar based admixtures (sucrose, sugar, and sugar cane liquid) for concrete and mortar of previous researches with age beyond 28 days (28 days, 56 days, and 84 days). Several mortar cubes and concrete cylinders specimens were produced by compressive strength design f'_c = 30 MPa and divided into variants of plain, added by sucrose, sugar , and sugar cane liquid admixture of with composition 0.03% and 0.3% by cement weight. All specimens are cured and then getting for compressive test at 28, 56, and 84 days. This research meets conclusions as follow: (1) The admixture of sugar 0.03% by weight of cement increases the compressive strength of mortar 7.83% at age 56 days and 11.09% at age 84 days while sugar cane liquid 0.3% by weight of cement has compressive strength of mortar increase by 7.42% at age 56 days and 12.20% at age 84 days. The highest increase is performed by the admixture of sugar 0.3% by weight of cement that has compressive strength of mortar increase by 28.17% at age 56 days and 32.34% age 84 days. Fluctuative compressive strength is performed by admixture of sucrose 0.3% and sugar cane liquid 0.03% by weight of cement with sharp increase at age 56 days (11.64% and 73.63%) but droply decrease at age 84 days, however, it still higher than the compressive strength at age 28 days (3.44% and 6.55%), (2) The admixture of sugar 0.03% by weight of cement increases the compressive strength of mortar 4.50% at age 56 days and 7.78% at age 84 days, while sugar 0.3% by weight of cement increases the compressive strength of mortar 5.97% at age 56 days and 11.91% at age 84 days. The phenomenon of fluctuative compressive strength shown by admixture of sucrose 0.03% and sugar cane liquid 0.03% by weight of cement with sharp increase at age 56 days

(54.35% and 33.32%) but droply decrease at age 84 days, however, it still higher than the compressive strength at age 28 days (29.08% and 5.36%), and (3) The admixture of sugar 0.03% and 0.3% by weight of cement show high increase of compressive strength for both mortar and concrete (4-33%). Fluctuative compressive strength phenomenon happened for both mortar and concrete with admixture of sugar cane liquid 0.03% by weight of cement.

Keywords: sugar, admixture, concrete, mortar, beyond 28 days

1. INTRODUCTION

The development of concrete admixture goes along the development of concrete technology. It is understood that the need of admixture is to impart considerable physical and economic benefits with respect to concrete [1]. It is said by Neville that the benefits covered the use of concrete under circumstances where previously there existed considerable, or even insuperable difficulties. Retarder admixture is one type of admixtures that is very useful to retard the chemical reaction of the cement and water leading to longer setting time and slower the initial strength gain while the accelerator perform the opposite behaviour [2].

Previous researches on the advantage of retarder admixture noted that sugar behaves as retarder that it delays cement setting [3]. The accelerator performs oppositte function, that is primarily to accelerate early strength development or hardening process, and also coincidentally accelerate the setting of concrete [1]. Certain optimal dosages of sugar in concrete have been investigated. Sugar will prolong cement setting by dosage of 0.03%-0.15% by weight of cement, and generate rapid setting of cement by dosage above 0.25% [4]. Some researches reported the advantage of sugar application in concrete mix ([3]-[10]). It is interesting that a serial research on sugar based admixture has been conducted and found that the sugar based admixture performs as retarder and accelerator and also gives compressive strength improvement ([11]-[21]).

Previous researches concluded that dosage of sugar and sugar cane liquid admixture of 0.03% by weight of cement can perform as retarder while dosage of sugar and sugar cane liquid admixture admixture of 0.3% by weight of cement can perform as accelerator ([17]-[21]). In the opposite, sucrose admixture acts as accelerator by dosage of 0.03% by weight of cement and as retarder by dosage of 0.3% by weight of cement. From the previous researches ([14], [18]), it is still questioned whether the compressive strength value increase or decrease on the older ages, beyond 28 days. This research wants to know the performance of sugar based admixtures (sucrose, sugar, and sugar cane liquid) for concrete and mortar of previous researches with age beyond 28 days (28 days, 56 days, and 84 days).

2. METHOD OF RESEARCH

Several mortar cubes and concrete cylinders specimens were produced by compressive strength design f'_c = 30 MPa and divided into variants of plain, added by sucrose, sugar, and sugar cane liquid admixture of with composition 0,03% and 0,3% by cement weight. The sugar which used in this research is local sugar with brand “Gulaku”. The

sugar cane liquid extracted from local sugar cane plantation from Klaten. All specimens are cured and then getting for compressive test at 28, 56, and 84 days.

3. RESULTS AND DISCUSSION

It is said by Young [22] that addition of sugar into concrete mix will make interaction between sugar and C_3A. It prevents rapid formation of cubic phase C_3AH_6 and generates the formation of hexagonal phase C_4AH_{13}. According to Collepardi, et. al. ([23], [24]), glucose, gluconate, and lignosulfonate will stabilize ettringite in C_3A-gypsum system. Therefore, glucose retards the consumption of gypsum and also formation of ettringite. For acceleration of the hydration of calcium silicates, calcium chloride is one compound ussualy used to accelerate the hydration of C3S by a slight change in the alkalinity of pore water or as a catalyst in the reaction of hydration [1].

Several previous researches proved that sugar based admixture perform both retardation and acceleration of cement and concrete hardening of age 7-28 days ([11]-[14], [17]-[21]). Their performance at age beyond 28 days will be reviewed by this paper. While plain concrete has improvement in strength from 28 days to 90 days about 20% (Wood, 1991, in [1]), then the concrete with sugar based admixture is expected to perform the same improvement.

Table 1. Compressive strength of concerete and mortar at age 28, 56, and 84 days (Modified from [15] and [16])

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No	Variant	% admixture by weight of cement	concrete	mortar	concrete	mortar	concrete	mortar
			Compressive strength (MPa)	Compressive strength (MPa)	Compressive strength (MPa)	Compressive strength (MPa)	Compressive strength (MPa)	Compressive strength (MPa)
			28 days	28 days	56 days	56 days	84 days	84 days
1	normal	0,00	30,11	42,96	40,18	42,08	36,22	45,36
2	sucrose	0,03	29,99	45,76	46,29	37,12	38,71	45,20
	sucrose	0,30	22,18	48,80	29,77	54,48	27,05	50,48
3	sugar	0,03	37,80	49,04	39,50	52,88	40,74	54,48
	sugar	0,30	34,18	40,32	36,22	51,68	38,25	53,36
4	sugar cane liquid	0,03	31,69	45,52	42,25	56,32	33,39	48,50
	sugar cane liquid	0,30	45,84	45,68	27,31	49,07	30,42	51,30

The results of experimet is described by Table 1. Figure 1 explains that some types of sugar based admixture give significant increase of compressive strength of mortar, they are sugar 0.03%, sugar 0.3%, sugar cane liquid 0.3% by weight of cement. The admixture of sugar 0.03% by weight of cement increases the compressive strength of

mortar 7.83% at age 56 days and 11.09% at age 84 days. Similar improvement shown by the admixture of sugar cane liquid 0.3% by weight of cement that has compressive strength of mortar increase by 7.42% at age 56 days and 12.20% at age 84 days. The highest increase is performed by the admixture of sugar 0.3% by weight of cement that has compressive strength of mortar increase by 28.17% at age 56 days and 32.34% age 84 days. Fluctuative compressive strength shown by the admixture of sucrose 0.3% and sugar cane liquid 0.03% by weight of cement. These types of admixture have sharp increase at age 56 days (11.64% and 73.63%) but droply decrease at age 84 days, however, it still higher than the compressive strength at age 28 days (3.44% and 6.55%). The decreasing of strength compressive strength is suspected because of 'broken' bonding of some concrete ingridients at age 56 days, but it becomes stable at age 84 days. However, this phenomenon need advance investigation on the future research.

Figure 2 explains the improvement of compressive strength of concrete contains sugar based admixture. Compressive strength increase shown by the admixture of sugar 0.03% and 0.3% by weight of cement. The admixture of sugar 0.03% by weight of cement increases the compressive strength of mortar 4.50% at age 56 days and 7.78% at age 84 days, while sugar 0.3% by weight of cement increases the compressive strength of mortar 5.97% at age 56 days and 11.91% at age 84 days. The phenomenon of fluctuative compressive strength also exist in concrete cylinder specimens. It is shown by admixture of sucrose 0.03% and sugar cane liquid 0.03% by weight of cement. These admixtures have sharp increase at age 56 days (54.35% and 33.32%) but droply decrease at age 84 days, however, it still higher than the compressive strength at age 28 days (29.08% and 5.36%).

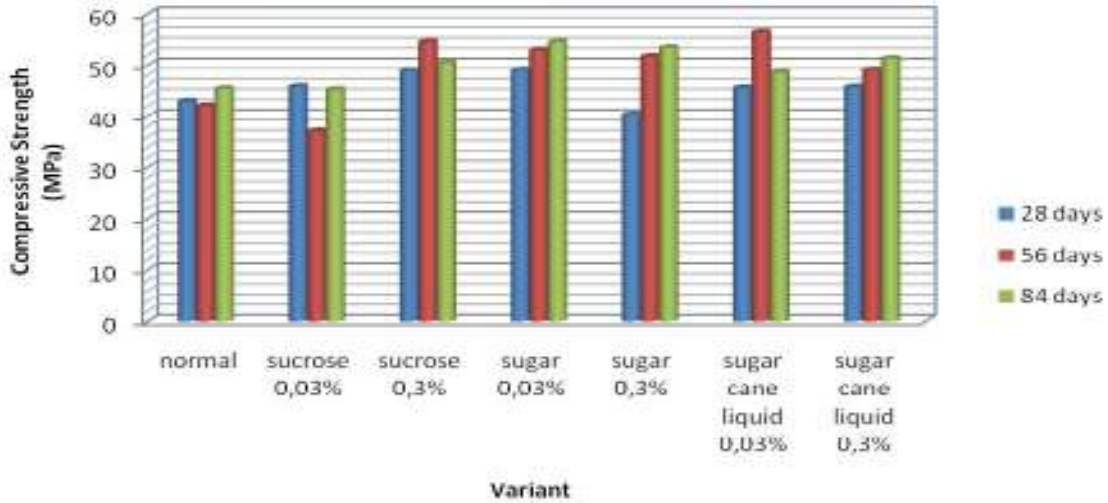

Figure 1. Mortar compressive strength of variants with sugar based admixture (Modified from [15] and [16])

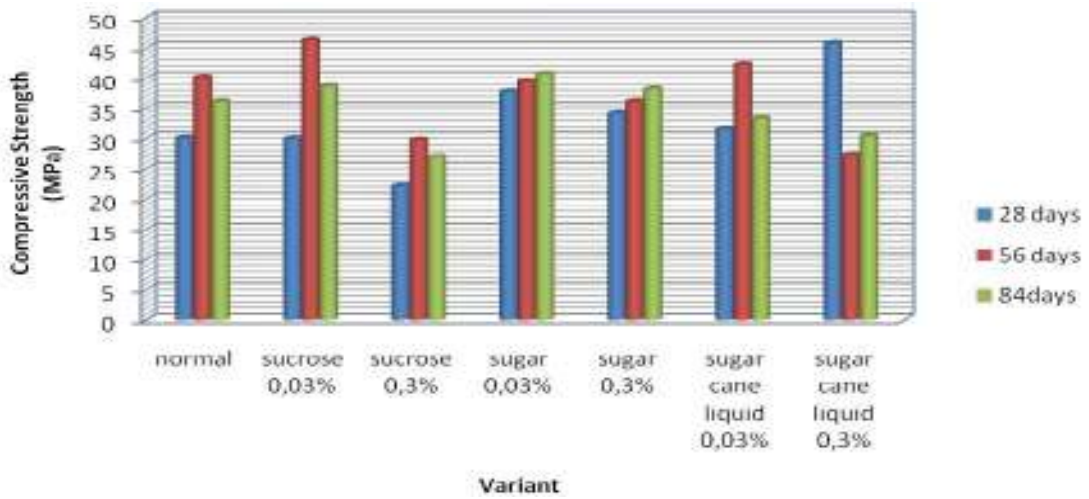

Figure 2. Concrete compressive strength of variants with sugar based admixture (Modified from [15] and [16])

The results of this research show that several types of sugar based admixture perform significant increase of compressive strength for mortar and also concrete as described by Figure 3. The admixture of sugar 0.03% and 0.3% by weight of cement show high increase of compressive strength for both mortar and concrete (4-33%). Same phenomenon of fluctuative compressive strength happened for both mortar and concrete with admixture of sugar cane liquid 0.03% by weight of cement. Hence, concrete with admixture of sugar 0.03% and 0.3% by weight of cement has good performance of compressive strength beyond age 28 days as also investigated by Wood, 1991, (in [1]). Further recommended research is to investigate the phenomenon of fluctuative compressive strength increase of mortar and concrete.

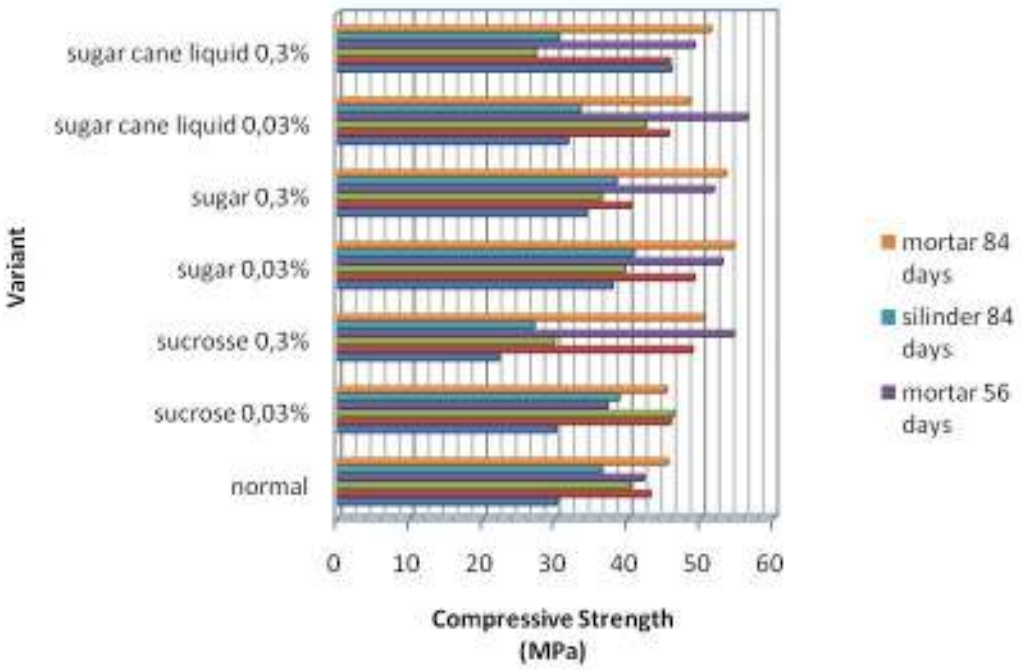

Figure 3. Comparison of concrete and mortar compressive strength of variants with sugar based admixture (Modified from [15] and [16])

5. CONCLUSIONS

This research meets conclusions as follow:

1) The admixture of sugar 0.03% by weight of cement increases the compressive strength of mortar 7.83% at age 56 days and 11.09% at age 84 days while sugar cane liquid 0.3% by weight of cement has compressive strength of mortar increase by 7.42% at age 56 days and 12.20% at age 84 days. The highest increase is performed by the admixture of sugar 0.3% by weight of cement that has compressive strength of mortar increase by 28.17% at age 56 days and 32.34% age 84 days. Fluctuative compressive strength is performed by admixture of sucrose 0.3% and sugar cane liquid 0.03% by weight of cement with sharp increase at age 56 days (11.64% and 73.63%) but droply decrease at age 84 days, however, it still higher than the compressive strength at age 28 days (3.44% and 6.55%)
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3) The admixture of sugar 0.03% and 0.3% by weight of cement show high increase of compressive strength for both mortar and concrete (4-33%). Fluctuative compressive strength phenomenon happened for both mortar and concrete with admixture of sugar cane liquid 0.03% by weight of cement

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