



Sugar Based Admixture for Promising ‘Green Concrete Technology’ - Improving Concrete Beam Performance with Sugar Based Admixture 0.03% of Cement Weight -

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Abstract

It is a duty of civil engineering to support sustainable development with ‘green concrete technology’. Previous researches have proven that some natural materials can be used as ‘green admixture’ for concrete. One promising ‘green concrete technology’ is conducted by this research. Sugar based admixture that is developed previously with dosage of 0.03% of cement weight is applied in concrete beam specimens to improve its performance. The research was conducted experimentally. There were 5 selected composition of sugar based admixture of previous invention by Susilorini. The concrete beam specimens were designed with $f'_c = 30$ MPa with 5 variants using selected composition of sugar based admixture from previous invention of Susilorini. These specimens are tested by third point loading test, and be analyzed for their modulus of rupture as parameter of concrete performance. The result shows that the modulus of rupture of concrete beams using sugar based admixture with dosage 0.03% of cement weight are 6.3-22.02% higher than the control beams. The highest increasing is performed by variant M-I-B-03. Sugar based admixture with dosage of 0.03% of cement weight has improved of modulus of rupture compared to the one which do not use the sugar based admixture.

KEYWORDS: sugar, admixture, concrete technology, beam

1. Introduction

A modern world needs promising infrastructure development. Civil engineering plays important role to determine the progress and even the future of ‘new world’ created by sustainable development. It can’t be denied that a duty of civil engineering field is supporting sustainable development with ‘green concrete technology’.

Simple definition of admixture is stated by ASTM C125 as “a material other than water, aggregates, hydraulic cements, and fiber reinforcement, used as an ingredient of concrete or mortar and added to batch immediately before or during mixing”. The admixture will affect the performance concrete, hence the ‘green admixture’ will also meet this purpose too.

When sugar based admixture is applied into mortar or concrete mix, sugar will stabilize ettringite in C_3A -gypsum system, retard consumption of

gypsum and formation of ettringite [1]. Later, sugar and C_3A will prohibit rapid formation of cubic phase C_3AH_6 but lead to form of hexagonal phase C_4AH_{13} [2]. This mechanism has become consideration of sugar based admixture using in concrete technology.

Previous researches have proven that some natural materials for concrete such as sugar, starch, and beet [1], [3-4] improves the performance of mortar and concrete significantly.

One promising ‘green concrete technology’ is conducted by this research. Sugar based admixture that is previously developed by Susilorini [5] with dosage of 0.03% of cement weight is applied in concrete beam specimens to improve its performance.

2. Method

The research was conducted experimentally. There were 5 selected composition of sugar based admixture of previous invention by Susilorini [5] that

is registered to patent process (Reg. No. P00201000309). The concrete beam specimens were designed with $f'_c = 30$ MPa with 5 variants using selected mix of sugar based admixture mentioned above. These specimens are tested by third point loading test, and be analyzed for their modulus of rupture as parameter of concrete performance which is expressed by [6],

$$R = \frac{PL}{bd^2} \quad (1)$$

Where R = modulus of rupture, which is defined as extreme fiber stress in bending (MPa) [7], P = load (N), L = beam span (mm), b = beam width (mm), and d = beam height (mm).

3. Result and Discussion

Sugar based admixture is proven as effective retarder and also accelerator in specific dosage [8, 9]. The mechanism of retarding can be explained as follow [8]. First, adsorption of retarder compound happened on the surface of cement particles will form protective skin and gets the hydration slow down. This adsorption activity works on nuclei of calcium hydroxide and poisons their growth that is important for advanced cement hydration after induction period. Then, formation of complex solution with calcium ions increases solubility and discourages the formation of the nuclei of calcium hydroxide. Finally, there will be precipitation around cement particles of insoluble derivatis of retarders compounds that is formed by reaction with highly alkaline aqueous solution which forms protective skin. The mechanism of retarding mentioned above allows retarding effects more effective in cement hydration. Therefore, higher compressive strength of concrete will become a result.

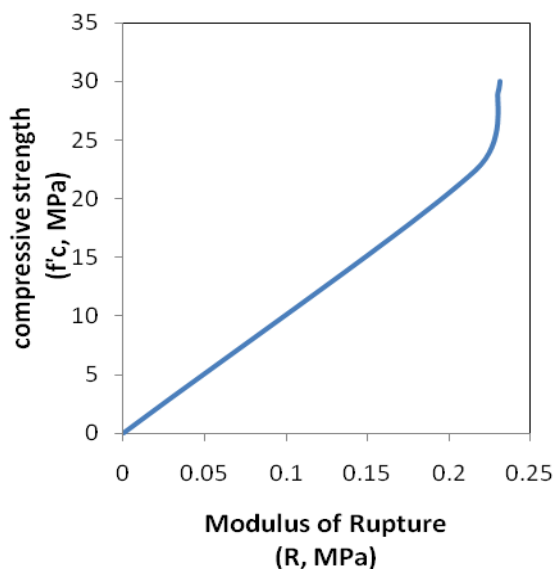


Fig. 1. Relation of modulus of rupture and its compressive strength [modified from 5, 10]



Fig. 2. Third point loading test for concrete beam specimens [10]

The experiment test (Fig 2) gave result that the modulus of rupture of concrete beams using sugar based admixture with dosage 0.03% of cement weight are 6.3-22.02% higher than the control beams [10]. The highest increasing is performed by variant M-I-B-03. There is an interesting relation (Fig 1) between modulus of rupture and its compressive strength of those sugar based admixture mix derived by previous research [5]. The performance of concrete beams can be described by a new equation (Eq. 2) of compressive strength-modulus of rupture relation,

$$y = 0.0005 + 0.0187 x - 0.000517 x^2 + 0.000005 x^3 \quad (2)$$

The relation of modulus of rupture and its compressive strength shows sharp bending of parabolic curve that means modulus of rupture will increase significantly at point of compressive strength around 25-30 MPa. Hence, the addition of sugar based admixture with dosage of 0.03% of cement weight will perform improvement of modulus of rupture compared to the one which do not use the sugar based admixture.

3. Conclusions

The research meets conclusions as follow.

- a. Sugar based admixture with dosage of 0.03% of cement weight (invention of Susilorini) works effectively in increasing the performance of concrete, especially compressive strength and modulus of rupture
- b. The addition of sugar based admixture with dosage of 0.03% of cement weight will perform improvement of modulus of rupture compared to the one which do not use the sugar based admixture.

- c. Sugar based admixture with dosage of 0.03% of cement weight is promising breakthrough of 'green concrete technology'

Berbasis Gula Sebesar 0.03% dari Berat Semen, Undergraduate Thesis, Department of Civil Engineering, Soegijapranata Catholic University, Semarang, 2010.

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