The influence of using accelerator addition on High strength self-compacting concrete (HSSCC) in case of enhancement early compressive strength and filling ability parameters

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The influence of using accelerator addition on High strength self-compacting concrete (HSSCC) in case of enhancement early compressive strength and filling ability parameters

Wibowo¹ and Y Fadillah²
¹ SmartConMart Research Group, Civil Engineering Department, Universitas Sebelas Maret, Surakarta, Indonesia
² Civil Engineering Department, Universitas Sebelas Maret, Surakarta, Indonesia.

E-mail : wibowotsipil87@gmail.com

Abstract. Efficiency in a construction works is a very important thing. Concrete with ease of workmanship and rapid achievement of service strength will to determine the level of efficiency. In this research, we studied the optimization of accelerator usage in achieving performance on compressive strength of concrete in function of time. The addition of variation of 0.3% - 2.3% to the weight of cement gives a positive impact of the rapid achievement of hardened concrete, however the speed of increasing of concrete strength achievement in term of time influence present increasing value of filling ability parameter of self-compacting concrete. The right composition of accelerator aligned with range of the values standard of filling ability parameters of HSSCC will be an advantage guidance for producers in the ready-mix concrete industry.

1. Introduction
There are several types of concrete that are classified based on the value of compressive strength, i.e. normal concrete, high quality concrete, and ultra-high strength concrete. High quality concrete is a concrete with a compressive strength more than 40 MPa, while ultra-high strength concrete is concrete with a compressive strength above 80 MPa. High quality concrete defined as concrete having a minimum compressive strength of 6000 psi or about 41 MPa [1].

High quality concrete has a high durability and low cement water factor ratio compared to conventional concrete that has only a compressive strength of 30 MPa - 40 MPa. To obtain a compressive strength until 60 MPa or equivalent to 650 kg/cm² can use the type of concrete self-compacting concrete. Self-compacting concrete is a very plastic and easy-flowing fresh concrete because its own weight can fill up throughout the mould. This concrete has the properties to solidify itself without the need for the aid of a vibrator commonly used in concrete compaction. SCC concrete is often called a flowing concrete because it has a very high slump value. Self-compacting concrete must have a homogeneous, cohesive, non-segregated, and no bleeding properties.

In order to achieve high workability Super plasticizer can used as an added ingredient that directly mixed into the mortar of concrete, and then to accelerate the hardening of concrete can use admixture materials. Added material (admixture) is a powder or liquid material, which added to the mixture of concrete during stirring in order to alter the nature of the mortar or its concrete.
In this research used accelerator as admixture. The use of the accelerator is very common for concrete casting in water, basalt waterproof work, seafront repair work in tidal areas, or if concrete structural elements are, need to be immediately burden by subsequent work in relation to strict execution time. This is because the accelerator main function is decrease duration of binding process and development of the initial strength of concrete. This material used to shorten cement-binding time to accelerate the achievement of concrete strength.

The use of this accelerator-added material should also consider the level of dissolved chloride ions in the required hard concrete, if exceeded would be at risk of corrosion in the iron or steel reinforcement. In the use of this accelerator should also pay attention to the time settings are faster and curing done should be as perfect as possible to achieve the desired higher initial strength.

2. Experimental

Objectives of the experimental program are planning accurately how to conduct research in laboratory. There are two type of approach for studying of SCC. Fresh concrete measured for observing self-compacting parameters. Hardened concrete gave the values of compressive strength that affected by accelerator addition [2].

2.1. Mix Proportion

In this study, repeated trial mixed design to obtain the proportion or composition of materials in accordance with the target research [3]. The composition of mortar mixture used is:

| Material used         | Control material | Dosage of accelerator |
|-----------------------|-------------------|------------------------|
|                       |                   | 0,4% | 1,2% | 2%  |
| Cement (kg)           | 15,47             | 15,41| 15,26| 15,106|
| Fine aggregates/sand (kg) | 15,82             | 15,82| 15,82| 15,82|
| Coarse (kg)           | 17,65             | 17,65| 17,65| 17,65|
| Water (ml)            | 4180              | 4163 | 4120 | 4079 |
| Super plasticizer (ml)| 247,48            | 246,11| 243,59| 241,14|
| Accelerator (ml)      | 0                 | 48,18| 143,07| 386,73|

3. Result and Discussion

3.1. Tests of Parameters of Self-Compacting Concrete (SCC)

Fresh concrete testing performed to see mixed concentration as a basis for ease of work. Fresh concrete tests for SCC include testing of flow table, L-box, and V-funnel.

3.1.1 L-Box Testing. In this research L-box, testing done to know the passing-ability of self-compacting concrete.

\[ PA \, (\%) = \frac{H_1}{H_2} \times 100\% \]  

(1)

Where:
PA: The initial high difference divided by the concrete end of the flow (passing Ability)
H1: Initial level of concrete flows (cm)
H2: The final height of the concrete flows (cm)
Table 2. Passing ability of fresh concrete

| No | Dosage of admixture | h1 (cm) | h2 (cm) | PL=h1/h2 |
|----|----------------------|---------|---------|----------|
|    | Super plasticizer   |         |         |          |
| 1  | 1.70%                | 8       | 8       | 1        |
| 2  | 1.70%                | 6.5     | 8       | 0.8125   |
| 3  | 1.70%                | 7.3     | 7.5     | 0.97333333 |
| 4  | 1.70%                | 7.5     | 7.8     | 0.961538462 |

In fresh concrete with lower accelerator content, passing-ability or the ability of concrete to pass the spacing between the reinforcement is better because accelerator is not quite enough to reduce duration of setting time, and vice versa the higher accelerator content then passing-ability of concrete to be slightly faltered because the time setting decrease significantly.

3.1.2. Slump Flow Testing. Flow Table Testing conducted to determine the filling-ability of self-compacting concrete.

Table 3. Result of filling-ability testing

| Dosage of admixture | d1 | d2  | Time (s) |
|---------------------|----|-----|----------|
| Super plasticizer   |    |     |          |
| 1.70%               | 740| 750 | 05.64    |
| 1.70%               | 660| 670 | 06.11    |
| 1.70%               | 680| 710 | 05.86    |
| 1.70%               | 730| 745 | 05.13    |

Filling ability of cement base material influenced by duration of setting time. In range accelerator addition between 0.4% until 2%, fresh concrete was satisfy with self-compacting concrete requirement properties.

3.1.3. V-funnel testing. V-funnel testing done to figure segregation resistance of self-compacting concrete. The test kit is made of a V-shaped steel plate and there is an opening valve at the bottom [4].

Table 4. Result of segregation resistance of self-compacting concrete

| Dosage of admixture | Time (s) |
|---------------------|----------|
| Super plasticizer   |          |
| 1.70%               | 0%       | 08.00    |
| 1.70%               | 2%       | 26.21    |
| 1.70%               | 1.20%    | 16.54    |
| 1.70%               | 0.40%    | 12.37    |

Result of the V-funnel test showed that accelerator influence performance of self-compacting concrete in term of segregation resistance, it could be understand that the duration of setting time decrease sharply when amount of accelerator raised.

The lower content of accelerator in cement paste show the best properties on segregation resistance or the ability of concrete to maintain the better homogeneity, and when the amount of accelerator
raise, ability to maintain homogeneity of concrete material decrease clearly and then finally affected quality of concrete as a member of structure.

3.1.4 V-Vunnel Testing T 5 second. V-funnel T5 minute test was conduct to determine segregation resistance of self-compacting concrete in 5 second after mixing. Using same instrument as V-funnel test but adding time lag 5 minutes after mixing. The following table illustrate the result of V-funnel T 5 second.

| Dosage of admixture | Time (s) |
|---------------------|----------|
|                     |          |
| Super plasticizer   |          |
| 1.70%               | 12.21    |
| 1.70%               | 65.33    |
| 1.70%               | 56.43    |
| 1.70%               | 52.65    |

V-funnel test T5 second is the most important result, because utilization of accelerator have to limit no more than 5 second time lag. Hence, all above result is out of range from minimal requirements SCC properties.

3.2. Compressive strength of self-compacting concrete

Compressive strength was measured use cylindrical specimen with diameter 15 cm and height 30 cm, where Compression Testing Machine (CTM) will crush this specimen at age 14 and 28 days. Content variations of accelerator used are 0.4%, 1.2%, and 2%. The following table show the detail various type of specimen used in this research.

| Specimen for compressive strength testing |
|------------------------------------------|
| Dosage of Super plasticizer | Dosage of Accelerator | Specimen code |
| 1.7% | 0% | BA A |
| 1.7% | 0.4% | SPACC A |
| 1.7% | 1.2% | SPACC B |
| 1.7% | 2% | SPACC C |

The dosage of accelerator varied, because objective of testing is determining trend and optimum dosage that satisfy with the properties of SCC and giving an optimum of compressive stress. Nevertheless, dosage of plasticizer is constant in order for minimizing plasticizer influence towards compressive strength of concrete.

In this test, specimen classified to be two group: specimen tested on 14 days and 28 days after remolding and curing. Variations of mixed accelerator dosage added with super plasticizer presented in table form as follows:

| Compressive Strength (MPa) | Dosage of Accelerator |
|---------------------------|-----------------------|
|                           | 0% | 0.4% | 1.2% | 2% |
| 14 days                   | 37.82 | 42.25 | 44.70 | 46.68 |
| 28 days                   | 41.87 | 44.79 | 47.91 | 53.66 |
Selection of testing time on days 14 and 28 is intend to observe from the time aspect whether SCC behavior is shown in Table 6 and Table 7, would be affected by result of the addition of accelerator and plasticizer.

![Figure 1](image1.png)

**Figure 1.** Compressive strength of SCC with addition accelerator and superplasticizer

If observation focused on accelerator dosage and how influence towards compressive strength of concrete, then it could be expressed that accelerator has significant role in order compressive strength of concrete attain as high as concrete without accelerator in shorter time. In case of self-compacting concrete, accelerator addition is unfavorable. Rapid setting-time give consequences, self-compacting concrete have to cast fast. **Figure 1** also illustrate in term of quality or strength, accelerator give positive contribution in raising compressive strength even more than 2%, but **Figure 2** indicates that the effect of adding the accelerator alone without the addition of plasticizer will have the best contribution in the range of 0.4% to 1.2%. It complement the results of previous studies [7], [8] and [9].

![Figure 2](image2.png)

**Figure 2.** Compressive strength with only accelerator addition
4. Conclusion
The role of the accelerator in the concrete material is to accelerate the achievement of compressive strength before the usual time (28 days), but from this research got the fact that accelerator greatly affect the fulfillment of self-compacting concrete standard, so only doses ranged 0.4% which meet all SCC specifications.

HSSCC testing for passing-ability and filling-ability parameters meets EFNARC standard, while for segregation resistance parameter does not meet EFNARC standard unless V-funnel test is 0.4%

In terms of the effect of the quality of concrete, the addition of accelerator contributes significantly to raising the quality of concrete. However, due to the limited compliance of self-compacting concrete specs, the best-recommended use of accelerator be in the dose range of 0.4% - 1.2%.

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Reference.
[1] Navyy, Edward G 1998 Beton Bertulang : Suatu Pendekatan Dasar (Bandung : PT Rafika Aditama)
[2] Sunarmasto, Kristiawan S, Putri N, & Basuki A 2013 J. Teknik Sipil: Universitas Sebelas Maret.
[3] The European Federation of National Trade Associations (EFNARC) 2001 Specification and guidelines for sel-compacting concrete (Farnham : Association House)
[4] Ozawa K, Sakata N, and Okamura H 1995 JSCE Concrete Lib. 25 59-75
[5] El Chabib H, Nehdi M 2006 ACI Mat J 103(5)
[6] Tan H, Bauguo M A, Xianguo L, Jian S, Yang H 2014 Wuhan University of Technology and Springer Verlag Berlin Heidelberg
[7] Betancourt G H 1998 J. Mat. Struct. 21 286-288
[8] S Chandra J, Bjornstro M 2002 J. Cem. Conc. Res. 32 1605-1611
[9] Kadek A P 2015 Perubahan Kuat Tekan Self Compacting Concrete yang Menggunakan Bahan Accelerator Concrete Admixture Type C yang disebabkan oleh Lingkungan Agresif (MgSO₄) di awal Perkerasan Beton (Bali : Universitas Udayana)