A Study on the Use of Mortar Utama Cement Type 420 as Concrete Admixture

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Abstract- This research was conducted at laboratory scale in the form of experiment for the purpose to know the value of concrete strength by using Mortar Utama Cement Type 420 as concrete mixing additive. The concrete mixing method being used was SNI 03-2834-2000. The concrete quality being used was K 250, K 300 and K 350. Additions of Mortar Utama Cement were for 5%, 10%, 15% and 20% of cement weight. The strength was tested on the 3rd, 14th, 21st and 28th days of concrete making. According to the test result, it can be concluded that the highest strength of concrete for K 250 with 5% addition was 275.09 Kg/cm², for K 300 with 5% addition was 325.32 kg/cm², while for K 350 with 5% addition was 368.48 kg/cm². Additions of Mortar Utama cement type 420 were able to influence the strength of concrete with simple linear regression model for K 250: \( Y = -2.005X + 272.7 \) with \( R^2 = 0.757 \), for K 300: \( Y = -3.061X + 328.3 \) with \( R^2 = 0.731 \), and for K 350: \( Y = -3.114X + 362.5 \) with \( R^2 = 0.785 \).

1. Introduction
Concrete is part of construction structure with important role in constructing. Concrete is a mix of cement, water, fine aggregate (sand), and coarse aggregate (gravel/split), added with various additional materials [1].

Mortar Utama Cement is manufactured by PT Cipta Mortar Utama, which is the first and the greatest national company to manufacture ready-to-
use instant cement (premixed mortar) using modern technology known by Mortar Utama brand. The main material of Mortar Utama cement is selected sand, cement PC 1 of the best quality of Holcim, premium filler and Europe additive.

Cement PC1 (Portland Cement 1) is cement type one of the best quality with high strength, filler contained inside it to improve its density and to reduce its mixing porosity, while the additive contained inside it is water additive useful to improve its consistency, adhesive capacity, water retention, durability and strength [2]. The use of additive for concrete mix gets more common in Indonesia. In general, additive used in concrete can be divided into two types: chemical natured additive and mineral natured additive.

Admixture is added during mixing and or during casting (placing), thus it is used more in improving casting performance. On the other hand, mineral natured additive is added during mixing, more cement-like work, used in improving its strength performance [3]. Mortar Utama cement has various types appropriate to its usage. This research uses an additive of Mortar Utama cement Type 420. Using additive of Mortar Utama cement Type 420, it is expected to improve the strength of concrete.

2. Materials and Methods

2.1. Materials

The research was carried out at the Laboratory of Main Station of the Office of Public Work of South Sumatera, Palembang, Indonesia. The materials used in this research were: Portland Cement, Holcim Cement brand, Coarse aggregate in the form of split stone from Lahat, South Sumatra, Fine aggregate in the form of sand from Sekayu, tap water from PDAM (Palembang City Water Utility company) Tirta Musi, and Admixture in the form of Mortar Utama Cement type 420 manufactured by PT Cipta Mortar Utama.

2.2. Methods

Methods of research included: 1) Examination of the characteristics of fine and coarse aggregates, namely testing of specific gravity and water absorption of coarse aggregate, testing of specific gravity and water absorption of fine aggregate, testing of analysis on fine and coarse aggregates, testing of water content of the aggregates; 2) Carrying out of normal concrete mix with additions of Mortar Utama Cement type 420 for 5%, 10%, 15% and 20% of cement weight used for each characteristic of concrete. 3) Concrete slump test. The test object was made using a mold.
15x15x15 cm with qualities of concrete being made were K 250, K 300 and K350 respectively. Concrete strength test was conducted on the 3rd, 14th, 21st and 28th days of concrete making.

3. Results and discussions

3.1. Test Result of Fine and Coarse Aggregate
The results are presented in Table 1, it can be stated that: the filter analysis is in zone I and qualifies as a concrete mixture [4].

| Table 1. Value of Characteristics of Fine and Coarse Aggregates. |
|---------------------------------------------------------------|
| Type of Test | Value |
|---------------|-------|
|               | Sand  | Split ¾ inch | Split 1 ½ inch |
| 1. Filter Analysis |       |               |               |
| 36.10 (1½”)  | 25.40 (1”) | - | 100 |
| 19.10 (3/4”) | 12.70 (1/2”) | - | 87.98 |
| 9.25 (3/8”)  | -     | 49.32 | 16.50 |
| # 4           | 98.04 | 87.98 | 0.00 |
| # 8           | 89.72 | -     | -   |
| # 16          | 72.19 | -     | -   |
| # 30          | 22.15 | -     | -   |
| # 50          | 1.04  | -     | -   |
| # 100         | 0.22  | -     | -   |
| # 200         | 0.12  | -     | -   |
| 2. Fineness modulus: | 3.17 | 6.92 | 7.83 |
| 3. Content Weight: Loose | 1.462 | 1.337 | 1.330 |
| Solid         | 1.551 | 1.415 | 1.419 |
| 4. Basic specific gravity of dry saturated surface | 2.54 | 2.57 | 2.58 |
| 5. Absorption ( % ) | 1.19 | 2.26 | 2.10 |
| 6. Organic dirt | No : 3 | - | - |
| 7. Through filter No.200 Mud Content | 0.60 % | - | - |
| 8. Wear (%) | - | - | 23.24 % |

Color standard organic dirt no 3 meets the required maximum no. 4, for the standard organic content of the color no. 5 the need for fine aggregate
washing before use [5]. The mud content of 0.60%, categorized as eligible from the maximum permissible sludge content of 5% [6]. Rough aggregate wear of 23.24%, meets normal standards permitted maximum 25% [6]. The fine aggregate fineness modulus of 3.17 qualifies between 2.5-38 and the rough aggregate fineness modulus of 6.92 and 7.83 qualifies between 6-8 [6]. From the available data, it follows that overall fine aggregate and coarse aggregate characteristics are eligible for use as concrete mixtures.

3.2. Concrete Mix Composition
The results presented in Table 2 are the composition of concrete mixture without addition of main mortar type 420 cement or concrete mixture with addition of main mortar type 420. Value of water factor of cement (w/c) Which can be calculated for concrete without the addition of the main mortar type 420 cement is 0.50 for the characteristics of K 250, K 300 and K 350 concrete. Along with the addition of 420.4%, 15% and 20% main mortar cement %, There was a decrease of cement water factor (w/c) respectively: 0.48, 0.46, 044 and 0.42 for all types of concrete characteristics. The value of the cement water factor (w/c) required in the range 0.50-0.45 [7]. The decrease in the value of the cement water factor (w/c) is due to an increase in the amount of cement in the concrete mixture while the amount of water remains.

| No | Type of Material                        | Need for Material 1 M³ |
|----|---------------------------------------|------------------------|
|    |                                       | K 250  | K 300  | K 350  |
| 1  | Cement                                | 402 kg | 451 kg | 500 kg |
| 2  | Sand                                  | 598 kg | 599 kg | 596 kg |
| 3  | Split size ¾ inch (19.00mm)           | 493 kg | 565 kg | 480 kg |
| 4  | Split size 1 1/2 inch (37.50mm)       | 669 kg | 548 kg | 579 kg |
| 5  | Water                                 | 205 liters | 225 liters | 250 liters |
| 6  | Mortar Utama Cement Type 420 5%       | 20.1 kg | 22.55 kg | 25 kg |
| 7  | Mortar Utama Cement Type 420 10%      | 40.2 kg | 45.1 kg | 50 kg |
| 8  | Mortar Utama Cement Type 420 15%      | 60.3 kg | 67.65 kg | 75 kg |
| 9  | Mortar Utama Cement Type 420 20%      | 80.4 kg | 90.20 kg | 100 kg |
3.3. Slump Value

Slump value test was conducted to each concrete mix. The result presented in table 3 showed that with the increase of main mortar type 420 inside the concrete mixture, then the slump value is decreased. For K 250 of 82 mm it decreases successively to 75 mm, 70 mm, 65 mm and 58 mm. This condition applies also to K 300 from 79 mm to 72 mm, 66 mm, 62 mm and 59 mm. To K 350 from 72 mm to 68 mm, 64 mm, 61 mm and 58 mm. For the addition of main mortar type 420 by 20% does not meet the specified requirement that the slump value should be in the range of 100-60 mm [7]. According to Asrullah [8] the decrease in slump value is due to an increase in the number of main mortar cement type 420 in concrete mix while the amount of water remains, so that the concrete mixture becomes thick and tend not homogeneous.

| Type of Concrete | Slump Value (mm) |
|------------------|------------------|
|                  | K 250 | K 300 | K 350 |
| Non-Added Concrete (0%) of Mortar Utama cement Type 420 | 82    | 79    | 72    |
| Concrete added with 5% of Mortar Utama cement Type 420 | 75    | 72    | 68    |
| Concrete added with 10% of Mortar Utama cement Type 420 | 70    | 66    | 64    |
| Concrete added with 15% of Mortar Utama cement Type 420 | 65    | 62    | 61    |
| Concrete added with 20% of Mortar Utama cement Type 420 | 58    | 59    | 58    |

3.4. Test Result of Strength

The results presented in Table 4 show that the standard deviation (S) value for the 28-day-old concrete is fluktuated and unstable. This is due to in each of the compressive strength of the concrete on the auxiliary characteristics there is a difference resulting in an inconsistent standard deviation (S). The results in Table 5 show that concrete without the addition of the main mortar type 420 (0%) meets the predetermined standard, ie for K 250 the compressive strength value is 261,69 kg/cm², K 300 the compressive strength value is 311,35 kg/cm², K 350 value of compressive strength 351,28 kg / cm². The value of compressive strength of concrete with the addition of main mortar type 420 is increased by the addition of main mortar type 420 by 5% of cement weight .ie K 250 value of compressive strength 275,09 kg /
cm², K 300 value of compressive strength 325,32 kg / cm², K 350 value of compressive strength 368,48 kg / cm². While the addition of main mortar type 420 by 10%, 15% and 20% decreased.

Table 4. Standard Deviation(S) of Concrete on the 28th Day.

| Type of Concrete | Standard Deviation (S) (kg/cm²) |
|------------------|---------------------------------|
|                  | K 250 | K 300 | K 350 |
| Non-Added Concrete (0%) | 0.69  | 0.56  | 2.49  |
| Mortar Utama cement Type 420, Concrete added with 5% of Mortar Utama cement Type 420 | 3.24  | 2.20  | 6.92  |
| Concrete added with 10% of Mortar Utama cement Type 420 | 3.63  | 2.85  | 3.34  |
| Concrete added with 15% of Mortar Utama cement type 420 | 6.42  | 4.25  | 5.89  |
| Concrete added with 20% of Mortar Utama cement type 420 | 0.45  | 1.28  | 6.79  |

Table 5. Concrete Strength on the 28th day.

| Type of Concrete | Strength of Concrete Characteristic (kg/cm²) |
|------------------|---------------------------------------------|
|                  | K 250 | K 300 | K 350 |
| Non-Added Concrete (0%) | 261.69 | 311.35 | 351.28 |
| Mortar Utama cement Type 420, Concrete added with 5% of Mortar Utama cement Type 420 | 275.09 | 325.32 | 368.48 |
| Concrete added with 10% of Mortar Utama cement Type 420 | 257.73 | 309.65 | 323.47 |
| Concrete added with 15% of Mortar Utama cement type 420 | 239.29 | 290.22 | 312.64 |
| Concrete added with 20% of Mortar Utama cement type 420 | 229.95 | 252.37 | 301.35 |

According to Asrullah [9] this is because there is a big change to the water factor of cement (w/c) accompanied by decrease of slump value which implication there is decrease of concrete compressive value. Even if there is an increase of concrete compressive strength value on the addition of 5% of
main mortar type 420 this is due to the change of cement water factor (w/c) and slump value is still in fairness, given the composition of the main mortar type 420 containing additives that have a role in increase the value of concrete compressive strength.

3.5. Simple Linear Regression Relationship Model

A simple linear regression analysis describes the relationship of a free variable (addition of Primary Cement type 420) and an independent variable (Concrete strength). In this research, the free variable (X) is addition of Mortar Main cement type 420, while the independent variable (Y) is concrete strength. The regression model in figure 1 is a simple linear regression for K 250 concrete which is the relationship between the value of concrete compressive strength with the addition of main mortar type 420 with the equation $Y = -2.005X + 272.7$. From this equation it is seen that the minus value [10] in the regression coefficient shows the dependent variable number (Y) based on the independent variable (X). This means that if the addition of Main Mortar Type 420 cement increases, it will cause a decline in the value of compressive strength of the concrete. Furthermore, according to Asrullah [11] the coefficient of determination $R^2$ is worth 0.757, this figure is close to the value of 1, it means to have a strong correlation between the addition of Main Mortar type 420 cement and the compressive strength of concrete. In addition, the coefficient shows that the effect of the addition of Mortar Utama Type 420 cement to the value of mortar compressive strength of 75.70%.

![Figure 1. Relationship between the Strength of Concrete K 250 and Addition of Mortar Utama Cement Type 420.](image)
The regression model in figure 2 is a simple linear regression for K 300 concrete which is the relationship between the value of concrete compressive strength with the addition of the main mortar type 420 with the equation $Y = -3.061X + 328.3$. From this equation it is seen that the minus value \[10\] in the regression coefficient shows the dependent variable number ($Y$) based on the independent variable ($X$). This means that if the addition of Main Mortar Type 420 cement increases, it will cause a decline in the value of compressive strength of the concrete. Furthermore, according to Asrullah [11] the coefficient of determination $R^2$ is worth 0.731, this number is close to the value of 1, it means to have a strong correlation between the addition of Main Mortar type 420 cement and concrete compressive strength. In addition, the coefficient shows that the effect of the addition of Mortar Utama Type 420 mortar to the value of mortar compressive strength of 73.10%.

![Figure 2](image_url)

**Figure 2.** Relationship between the Strength of Concrete K 300 and Addition of Mortar Utama Cement Type 420.

The regression model in figure 3 is a simple linear regression of concrete K 350 which is the relationship between the value of concrete compressive strength with the addition of main mortar type 420 with the equation $Y = -3.114X + 362.5$. From this equation it is seen that the minus value \[10\] in the regression coefficient shows the dependent variable number ($Y$) based on the independent variable ($X$). This means that if the addition of Main Mortar Type 420 cement increases, it will cause a decline in the value of compressive strength of the concrete. Furthermore according to Asrullah [11] the coefficient of determination $R^2$ is worth 0.7851, this number is close to the value of 1, it means to have a strong correlation between the addition of Main Mortar type 420 cement and concrete compressive strength. In
addition, the coefficient shows that the effect of the addition of Main Mortar Type 420 cement to the value of mortar compressive strength of 78.51%

![Figure 3](image)

**Figure 3.** Relationship between the Strength of Concrete K 350 and Addition of Mortar Utama Cement Type 420.

The relationship between addition of Mortar Main cement type 420 (free variable) and slump value (independent variable) is presented in figures 4,5,6. The regression model in figure 4 is a simple linear regression of K 250 which is the relationship between the slump value of the concrete with the addition of the main mortar type 420 with the equation $Y = -1.16X + 81.6$. From this equation it is seen that the minus value [10] in the regression coefficient shows the dependent variable number (Y) based on the independent variable (X). This means that if the addition of Main Mortar Type 420 cement increases, it will cause a decrease in slump value. Furthermore, according to Asrullah [11] the coefficient of determination $R^2$ is worth 0.995, this figure is close to the value of 1, it means to have a strong correlation between the addition of Main Mortar Type 420 cement and concrete slump value. In addition, the coefficient shows that the effect of the addition of Mortar Utama Type 420 mortar to the value of mortar compressive strength of 99.50%.

The regression model in figure 5 is a simple linear regression of K 300 which is the relationship between the slump value of concrete with the addition of the main mortar type 420 with the equation $Y = -X + 77.6$. From this equation it is seen that the minus value [10] in the regression coefficient shows the dependent variable number (Y) based on the independent variable (X).
This means that if the addition of Main Mortar Type 420 cement increases, it will cause a decrease in slump value. Furthermore according to Asrullah [11] the coefficient of determination $R^2$ is worth 0.972, this number is close to the value of 1, it means to have a strong correlation between the addition of Main Mortar type 420 cement and concrete slump value. In addition, the coefficient shows that the effect of the addition of Mortar Main Type 420 cement to the value of mortar compressive strength of 97.20%.

The regression model in figure 6 is a simple linear regression $K 350$ which is the relationship between the slump value of concrete with the addition of the main mortar type 420 with the equation $Y = -0.7X + 71.6$. 

![Figure 4. Relationship of Slump Value of Concrete K 250 and Addition of Mortar Utama Cement Type 420.](image)

![Figure 5. Relationship between Slump Value of Concrete K 300 and Addition of Mortar Utama Cement Type 420.](image)
From this equation it is seen that the minus value [10] in the regression coefficient shows the dependent variable number (Y) based on the independent variable (X). This means that if the addition of Main Mortar Type 420 cement increases, it will cause a decrease in slump value.

Furthermore according to Asrullah [11] the coefficient of determination $R^2$ is worth 0.9943, this number is close to the value of 1, it means to have strong correlation between addition of Main Mortar Type 420 cement and concrete slump value. In addition, the coefficient shows that the effect of the addition of Mortar Utama Type 420 mortar to the value of mortar compressive strength of 99.43%.

4. Conclusions
From the result of this research, we conclude that:
1. The highest strength of concrete K 250 was achieved by adding 5% of Mortar Utama Cement Type 420 with strength value 275.09 kg/cm$^2$, $Y = -2.005X + 272.7$ with $R^2 = 0.757$.
2. The highest strength of concrete K 300 was achieved by adding 5% of Mortar Utama Cement Type 420 with strength value 325.32 kg/cm$^2$, $Y = -3.061X + 328.3$ with $R^2 = 0.731$.
3. The highest strength of concrete K 350 was achieved by adding 5% of Mortar Utama Cement Type 420 with strength value 368.48 kg/cm$^2$, $Y = -3.114X + 362.5$ with $R^2 = 0.785$

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