ANALYSIS OF FIBER CONCRETE COMPRESSION STRENGTH FOR MATERIAL IN PALANGKA RAYA

Noviyanthy Handayani¹, Hendra Cahyadi¹
¹Department of Civil Engineering, Faculty of Engineering, Muhammadiyah Palangkaraya University, Palangka Raya 73111, Indonesia; Corresponding Author: novisipilump@gmail.com, irarizqonroyan@gmail.com

Abstract
The technology of materials and technical implementation of experiment results have purposes to answer the increasing demands of concrete using. It used to perform the further research on the use of local materials for fiber concrete. In the particular study, it tried to use mixtures of; first, the mixtures of synthetic fibers and mixtures of 0.3 percent, 0.5 percent, and 0.7 percent of the cement, second, the mixture of fiber concrete wire and mixtures of 3 percent, 5 percent, and 7 percent of the cement. The results of compression strength test using 15 x 15 x 15 concrete cube obtained, the score of maximum compression strength in the percentage mixture of 5 percent fiber concrete wire in age of 28 days is 275.39 kg/cm² or increase 9.99 percent of normal concrete in age of 28 days is 250.38 kg/cm².

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1. Introduction
Today, the construction development in Indonesia increase rapidly. Along with the developments, there is also higher of the need of concrete use as one type of construction materials. Concrete can be used in most of civil buildings such as building structures, water structures, and pavement construction. Concrete has advantages such as high compression strength, easy to be made according to reference, fireproof and cheap. In contrast, the weaknesses of concrete are brittle, heavy of specific density, and etc.

The numbers of research and experiments in the field of concrete is performed to improve the quality of concrete. The technology of materials and technical implementation of experiment results have purposes to answer the increasing demands of concrete using and problem solving toward the occurred problem in the process. In the construction of high-rise buildings and other public buildings, it needs high strength concrete, especially the compression strength. A way to increase the compression strength of the concrete is by giving additional materials such as fiber. By giving of fiber as additional material, it expects to be able to increase the compression strength of the concrete.

The types of fiber materials to improve the properties of concrete are Metallic Fiber, Polymeric Fiber, Naturally Ocurring Fiber, and Polymeric Fiber. In Indonesia, the concept of using steel fibers on concrete mixture for civil engineering structures has not been widely known and has not been used in practice. This is another reason to do research on use of fiber as additional material of concrete. And typically, the fiber is easy to find in Central Kalimantan Province for the manufacture of concrete.

2. Literature Review
General Description
Starting from planning, implementation, until the analysis stages, the research conducted according to resources relating to selected topic, i.e. “Analysis of fiber concrete compression strength”. The resources are the rules, references, and previous relevant studies.

Original Concrete

Concrete is the material mixture of fine aggregate, coarse aggregate, Portland cement, and water. As the increases age, the concrete will be harder, and will reach the strength of the plan (f'c) at age of 28 days. The quick of strength increasing of the concrete is strongly influenced by the cement, water, and the temperature during the treatment.

Good original concrete is original concrete that is easily stirred, easy to transport, easy to pour, easy to compact and no tendency for segregation or bleeding. Good heavy concrete is a strong, durable, water-resistant, wear-resistant, and slightly changed the volume or the small of shrinkage.

Types of Concrete

The types of concrete are:

a. Light-Weight Concrete
   Light-weight concrete is concrete made with dead load and capability of thermal conductivity is less than 1800 kg / m3.

b. Mass Concrete
   Mass concrete is a concrete poured in large volumes, ie the ratio of volume and surface area is large. The dimension of mass concrete is usually more than 60 cm.

c. Ferrosemen
   Ferrosemen is a composite material obtained by providing reinforcement of woven steel wire to give of tensile strength and ductility in cement mortar.

d. Fiber Concrete
   Fiber Concrete is a composite part consisting of original concrete and other materials of fiber. The fiber in this concrete serves to prevent cracks, so the concrete is more ductile than original concrete.

e. No-Fines Concrete
   No-Fines Concrete is a simple form of light-weight concrete type obtained by removing the part of fine aggregate on the concrete manufacture. The no-fine aggregate in the mixture produces a system of cavities distributed within the mass concrete and reducing the concrete weight.

f. Cyclop Concrete
   Cyclops Concrete is original concrete that use relatively large aggregate sizes. The size of the coarse aggregate might be up to 20 cm, but the larger proportion of aggregate should be no more than 20 percent of the total aggregate.

g. Hollow Concrete
   Hollow Concrete is a stirred, poured, and compacted concrete same as the original concrete. The residual water is aspirated in a special way called as vacuum, then leaving only water for reaction with cement. And, the concrete is very strong.

h. Mortar Concrete
   Mortar concrete is a mixture of sand, adhesives, and water. Mortar can be divided into three: mortar mud, lime mortar, and mortar cement.
Fiber Concrete

According to American Concrete Institute (ACI), fiber concrete is a concrete construction with materials composed of cement, fine aggregate, coarse aggregate and small amounts of fibers dispersed randomly in the original concrete mixtures.

Fiber concrete is a composite material composed of original concrete and other materials of fiber. Fiber is generally a rod with diameter of 5 to 500 μm (micrometer) and length of about 25 - 100 mm. Fiber materials may be asbestos fibers, plant fibers (hemp, bamboo, fibers), plastic fibers, glass fibers / synthetic or pieces of steel wire.

2. Research Method
The research procedures is presented in figure 1:

![Flow Chart of the Research](image)

**Figure 1.** Flow Chart of the Research

Materials and Tools
The object materials of this research are the available fiber in Palangka Raya. They are:
1. Metallic Fiber using concrete wire.
2. Polymeric Fiber using synthetic.
3. Other materials are coarse aggregate (crushed stone), fine aggregate (sand), cement, and water

3. Data Analysis
Calculation of the mixture propotion of no-fibers concrete
Recapitulation of the total of no-fibers concrete material per 1 m3 is presented in Table 1:
Table 1. Mixture Proportion of No-Fibers Concrete

| The total of theoretical materials | Cement (Kg) | Water (Kg) or (Liter) | Fine Aggregate (Kg) | Coarse Aggregate (Kg) |
|-----------------------------------|-------------|----------------------|--------------------|----------------------|
| Per m³                            | 386.79      | 183.36               | 680.31             | 1.129.54             |

Calculation of the mixture proportion of fibers concrete

In the particular study, the calculation of the mixture proportion of fibers concrete is equal to original concrete; ie K-250, but there are addition of fibers through the calculation of total cement per m³. It is because there are significant differences between the fibers weight of wire concrete and synthetic fibers, if, for example, based on the calculations of mixture volume or against the aggregate. The calculation in determining the fibers addition is explained:

Fibers weight per m³ = Weight of cement x 0.3%

= 386.79 x 0.3%

= 1.160 kg/m³

The results are presented in table 2:

Table 2. The calculation of fibers addition

| Synthetic | Weight Fiber (kg) | Wire Concrete | Weight Fiber (kg) |
|-----------|-------------------|---------------|-------------------|
| 0.3%      | 1.16037           | 3%            | 11.60370          |
| 0.5%      | 1.93395           | 5%            | 19.33950          |
| 0.7%      | 2.70753           | 7%            | 27.07530          |

4. Data Analysis

Testing Result of Workability

Based on the workability testing of original concrete and fibers concrete that gained from the stirred process and measured on every stir, are presented in table 3:

Table 3 Workability Testing result of Original Concrete and Fibers Concrete

| Concrete | Synthetic | Wire Concrete |
|----------|-----------|---------------|
|          | Slump (mm)| Slump (mm)    |
| Original | 0.3%      | 0.5%          |
|          | 0.7%      | 3.0%          |
|          | 5.0%      | 7.0%          |
| Slump (mm)| 85       | 80            |
|          | 74        | 73            |
|          | 65        | 56            |

In the fiber concrete, the slump is lower than original concrete. Based on Table 3, concluded that the greater the fiber addition, the smaller the workability occurs. It is because the
greater the fiber addition, the more difficult of working process, and impact to the decreased workability.

Testing Result of Compression Strength of Original Concrete and Fiber Concrete (Synthetic)

The concrete compression strength is influenced by several factors such as the cement stickiness to the aggregate, and the composition and strength of the stacking material. The concrete compression strength is greater than the concrete tensile strength. This property is often used as a material structure. The calculation result of the compression strength between original concrete and fibers concrete (synthetic), is presented in Table 4 and Figure 2.

Table 4. Compression Strength of Original Concrete And Fibers Concrete (Synthetic)

| No | Type of Samples | Testing Age (Days) | Testing Result (kg/cm²) | Age Correlation | Cuber Strength Age of 28 days (Tb) (kg/cm²) | Tension Average (kg/cm²) | (Tb-Tb)² | Standard Deviation | Teg Characteristic (Tbk) Kg/cm² |
|----|-----------------|--------------------|-------------------------|-----------------|---------------------------------------------|--------------------------|----------|-------------------|---------------------------------|
| 1  | Normal          | 7                  | 186,67                  | 0,65            | 287,18                                      | 266,92                   | 410,530  | 16,54             | 250,38                          |
| 2  | Normal          | 7                  | 191,11                  | 0,65            | 294,02                                      | 266,92                   | 734,364  | 16,54             | 250,38                          |
| 3  | Normal          | 7                  | 182,22                  | 0,65            | 280,34                                      | 266,92                   | 180,202  | 16,54             | 250,38                          |
| 4  | Normal          | 14                 | 235,56                  | 0,88            | 267,68                                      | 266,92                   | 87,276   | 16,54             | 250,38                          |
| 5  | Normal          | 14                 | 226,67                  | 0,88            | 257,58                                      | 266,92                   | 87,276   | 16,54             | 250,38                          |
| 6  | Normal          | 28                 | 254,97                  | 1,00            | 254,97                                      | 266,92                   | 142,735  | 16,54             | 250,38                          |
| 7  | Normal          | 28                 | 245,61                  | 1,00            | 245,61                                      | 266,92                   | 453,856  | 16,54             | 250,38                          |
| 8  | Normal          | 28                 | 257,31                  | 1,00            | 257,31                                      | 266,92                   | 92,314   | 16,54             | 250,38                          |
| 9  | Synthetic      | 0.3%               | 7                      | 191,11          | 0,65                                        | 294,02                   | 679,098  | 15,75             | 250,38                          |
| 10 | Synthetic      | 0.3%               | 7                      | 182,22          | 0,65                                        | 280,34                   | 153,371  | 15,75             | 252,21                          |
| 11 | Synthetic      | 0.3%               | 7                      | 186,67          | 0,65                                        | 287,18                   | 369,482  | 15,75             | 252,21                          |
| 12 | Synthetic      | 0.3%               | 14                     | 231,11          | 0,88                                        | 262,63                   | 28,423   | 15,75             | 252,21                          |
| 13 | Synthetic      | 0.3%               | 14                     | 235,56          | 0,88                                        | 267,68                   | 0,079    | 15,75             | 252,21                          |
| 14 | Synthetic      | 0.3%               | 14                     | 222,22          | 0,88                                        | 252,53                   | 238,157  | 15,75             | 252,21                          |
| 15 | Synthetic      | 0.3%               | 28                     | 250,29          | 1,00                                        | 250,29                   | 312,059  | 15,75             | 252,21                          |
| 16 | Synthetic      | 0.3%               | 28                     | 254,97          | 1,00                                        | 254,97                   | 168,657  | 15,75             | 252,21                          |
| 17 | Synthetic      | 0.3%               | 28                     | 261,99          | 1,00                                        | 261,99                   | 35,632   | 15,75             | 252,21                          |
| 18 | Synthetic      | 0.3%               | 7                      | 191,11          | 0,65                                        | 294,02                   | 559,683  | 15,08             | 255,28                          |
| 19 | Synthetic      | 0.5%               | 7                      | 186,67          | 0,65                                        | 287,18                   | 282,913  | 15,08             | 255,28                          |

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| No | Type     | Grade | Age (Day) | Compression Strength (kg/cm²) |
|----|----------|-------|-----------|-------------------------------|
| 21 | Synthetic | 0.5%  | 7         | 186.67, 0.65                 |
| 22 | Synthetic | 0.5%  | 14        | 235.56, 0.88                 |
| 23 | Synthetic | 0.5%  | 14        | 233.33, 0.88                 |
| 24 | Synthetic | 0.5%  | 14        | 228.89, 0.88                 |
| 25 | Synthetic | 0.5%  | 28        | 257.31, 1.00                 |
| 26 | Synthetic | 0.5%  | 28        | 261.99, 1.00                 |
| 27 | Synthetic | 0.5%  | 28        | 252.63, 1.00                 |
| 28 | Synthetic | 0.7%  | 7         | 191.11, 0.65                 |
| 29 | Synthetic | 0.7%  | 7         | 186.67, 0.65                 |
| 30 | Synthetic | 0.7%  | 14        | 237.78, 0.88                 |
| 31 | Synthetic | 0.7%  | 14        | 237.78, 0.88                 |
| 32 | Synthetic | 0.7%  | 14        | 233.33, 0.88                 |
| 33 | Synthetic | 0.7%  | 28        | 252.63, 1.00                 |
| 34 | Synthetic | 0.7%  | 28        | 261.99, 1.00                 |
| 35 | Synthetic | 0.7%  | 28        | 261.99, 1.00                 |
| 36 | Synthetic | 0.7%  | 28        | 261.99, 1.00                 |

**Figure 2.** Compression Strength of Original Concrete and Fiber Concrete (Synthetic)

Based on Table 4 and Figure 2, the most optimal result is concrete using synthetic fiber of 0.7 percent. The highest test result of concrete compression strength on 0.7 percent of synthetic fibers from 3 samples at age 28 days is 257.96 kg/cm².
Testing Result of Compression Strength of Fiber Concrete Wire Fibers

The calculation testing results of concrete compression strength of concrete wire fibers are presented in Table 5 and Figure 3:

**Table 5. Concrete Compression Strength of Concrete Wire Fibers**

| No | Type of Samples | Testing Age (Days) | Testing Result (kg/cm²) (F'c) | Age Correlation (Conv. F'c) | Cuber Strength Age of 28 days (Tb) (kg/cm²) (F'c) | Tension Average (kg/cm²) (Tb) (F'cr) | (Tb-Tb')² Kg/cm² (F'c - F'cr)² | Standard Deviation (S) | Teg Characteristic (Tk) Kg/cm² (F'ck) |
|----|-----------------|-------------------|-------------------------------|-----------------------------|---------------------------------|---------------------------------|---------------------------------|----------------|----------------------------------|
| 1  | Concrete Wire 3% Concrete | 7 | 191,11 | 0.65 | 294.02 | 276.48 | 307.404 | 16.16 | 260.32 |
| 2  | Concrete Wire 3% Concrete | 7 | 191,11 | 0.65 | 294.02 | 276.48 | 307.404 | 16.16 | 260.32 |
| 3  | Concrete Wire 3% Concrete | 7 | 195.56 | 0.65 | 300.85 | 276.48 | 593.924 | 16.16 | 260.32 |
| 4  | Concrete Wire 3% Concrete | 14 | 235.56 | 0.88 | 267.68 | 276.48 | 77.570 | 16.16 | 260.32 |
| 5  | Concrete Wire 3% Concrete | 14 | 240.00 | 0.88 | 272.73 | 276.48 | 14.114 | 16.16 | 260.32 |
| 6  | Concrete Wire 3% Concrete | 14 | 244.44 | 0.88 | 277.78 | 276.48 | 1.673 | 16.16 | 260.32 |
| 7  | Concrete Wire 3% Concrete | 28 | 261.99 | 1.00 | 261.99 | 276.48 | 210.129 | 16.16 | 260.32 |
| 8  | Concrete Wire 3% Concrete | 28 | 257.31 | 1.00 | 257.31 | 276.48 | 367.650 | 16.16 | 260.32 |
| 9  | Concrete Wire 3% Concrete | 28 | 261.99 | 1.00 | 261.99 | 276.48 | 210.129 | 16.16 | 260.32 |
| 10 | Concrete Wire 5% Concrete | 7 | 191.11 | 0.65 | 294.02 | 286.37 | 58.475 | 10.98 | 275.39 |
| 11 | Concrete Wire 5% Concrete | 7 | 200.00 | 0.65 | 307.69 | 286.37 | 454.631 | 10.98 | 275.39 |
| 12 | Concrete Wire 5% Concrete | 7 | 191.11 | 0.65 | 294.02 | 286.37 | 58.475 | 10.98 | 275.39 |
| 13 | Concrete Wire 5% Concrete | 14 | 253.33 | 0.88 | 287.88 | 286.37 | 2.276 | 10.98 | 275.39 |
| 14 | Concrete Wire 5% Concrete | 14 | 248.89 | 0.88 | 282.83 | 286.37 | 12.545 | 10.98 | 275.39 |
| 15 | Concrete Wire 5% Concrete | 14 | 248.89 | 0.88 | 282.83 | 286.37 | 12.545 | 10.98 | 275.39 |
| 16 | Concrete Wire 5% Concrete | 28 | 271.35 | 1.00 | 271.35 | 286.37 | 225.757 | 10.98 | 275.39 |
| 17 | Concrete Wire 5% Concrete | 28 | 280.70 | 1.00 | 280.70 | 286.37 | 32.132 | 10.98 | 275.39 |
| 18 | Concrete Wire 5% Concrete | 28 | 276.02 | 1.00 | 276.02 | 286.37 | 107.057 | 10.98 | 275.39 |
| 19 | Concrete Wire 7% Concrete | 7 | 191.11 | 0.65 | 294.02 | 278.08 | 253.833 | 14.71 | 263.37 |
| 20 | Concrete Wire 7% Concrete | 7 | 195.56 | 0.65 | 300.85 | 278.08 | 518.462 | 14.71 | 263.37 |
| 21 | Concrete Wire 7% Concrete | 7 | 191.11 | 0.65 | 294.02 | 278.08 | 253.833 | 14.71 | 263.37 |
| 22 | Concrete Wire 7% Concrete | 14 | 240.00 | 0.88 | 272.73 | 278.08 | 28.705 | 14.71 | 263.37 |
| 23 | Concrete Wire 7% Concrete | 14 | 244.44 | 0.88 | 277.78 | 278.08 | 0.094 | 14.71 | 263.37 |
| 24 | Concrete Wire 7% Concrete | 14 | 240.00 | 0.88 | 272.73 | 278.08 | 28.705 | 14.71 | 263.37 |
| 25 | Concrete | 28 | 261.99 | 1.00 | 261.99 | 278.08 | 259.102 | 14.71 | 263.37 |
Based on Table 5 and Figure 3, the most optimal result is concrete using wire concrete of 5 percent. The highest test result of concrete compression strength on 5 percent of wires concrete from 3 samples at age 28 days is 275.39 kg/cm².

5. Conclusions

1. The fiber addition will decrease the workability. It based on the decreasing of slump score on concrete. This is because the higher of addition, the more difficult of working process, and impact to the decreased workability.

2. The optimum of compression strength of the research on mixture percentage of 5 percent wire concrete in age of 28 days is 275.39 kg/cm² or increase 9.98 percent of original concrete in age of 28 days is 250.38 kg/cm².

3. The decreasing of compression strength score on fiber addition proportion of 7 percent wire concrete is caused by the higher of fiber addition into concrete mixture; then, it will reduce the concrete volume that the volume should have filled by cement.

Suggestions

1. During the fiber concrete making, need to consider on working process, in order gain the no-lump, compacted and no-brittle fiber.

2. Need a further research on optimal synthetic fiber form and wire concrete. The form of optimal wire fibers will provide optimal result and other fibers.
3. Not only compression strength, but also need further research on tensile strength, flexural strength of fiber concrete, or impact test to determine the shock load and elastic modulus to determine the ability of tension (load) withstand.

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