Utilization of copper fiber waste to increase compressive strength and split tensile strength of rigid pavement

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Abstract. The rigid pavement is a pavement construction in which a concrete slab is used as the top layer, which is located above the foundation or directly above the subgrade, without or with an asphalt surface layer. One type of rigid pavement used in Indonesia is rigid pavement without using reinforcement which is usually used in areas with low traffic or residential areas. Pavement without using reinforcement is the small split tensile strength so that the part of the plate will experience cracks due to stresses that cannot be avoided from traffic loads. Therefore, it is necessary to have reinforcement on the concrete slab so that the cracks do not extend. In this research, the use of copper fiber waste from electronic cables as a substitute solution for reinforcement to be used as a mixture in concrete. The experiments were carried out using fiber with variations of 0%, 0.5%, 1%, and 1.5% of the total weight of concrete mixture material and then tested at 28 days of concrete age. This research showed the variation of fiber weight until 1,5% increase the split tensile strength up to 32,46% and the compressive strength up to 9,16%.

1. Introduction

The rigid pavement is an arrangement of road pavement construction consisting of cement concrete slabs that are located on the foundation or directly on the subgrade. Rigid pavement has a high modulus of elasticity, which will distribute the load from underground traffic over a large area [1]. In determining the strength of a rigid pavement structure while holding traffic loads, what is meant is the strength of the rigid pavement itself, while the basic strength of the pavement does not affect the bearing capacity of the rigid pavement structure [2]. One type of rigid pavement used in Indonesia is unreinforced concrete pavement. Usually, this type of rigid pavement is used in residential areas because of low traffic. The use of rigid pavement has advantages, one of which is the compressive strength which is the main characteristic of concrete so that it can withstand traffic loads, while the weakness of rigid pavement is the occurrence of small cracks due to large traffic loads entering the road pavement. And cause the concrete pavement to be easily damaged due to the split tensile strength [3]. Concrete is very small, so a mixture is needed that can increase split tensile on rigid pavements by utilizing copper fiber waste as an alternative to increasing the tensile strength of the concrete [4]. Fiber concrete is concrete that has a mixture of coarse aggregate, fine aggregate, water, cement and uses fiber-added ingredients that are mixed evenly at the time of mixing. The basic idea of the added material for the fiber concrete mixture is to provide fiber as reinforcement to the concrete through a random orientation so that it is expected to reduce cracks in the concrete that occur in the tensile area, both during the heat of hydration and when it is due to loading [5]. Due to the nature of copper fiber which is resistant to corrosion and has a slippery surface texture, it encourages this research to find out how it affects rigid pavement. The

purpose of this research knowing the effect of the utilization of copper fiber waste in the mixture of concrete constituents for the rigid pavement with a mix of copper fibers on the rigid pavement (8 cm long and 0.8 mm in diameter) with fiber variations of 0%, 0.5%, 1% and 1.5% of the weight of the concrete mixture at the age of 28 days [1,6,7].

2. Methods

The research method used is laboratory experimental methods in the Material and Construction Laboratory of the Faculty of Civil Engineering, Christian University of Indonesia by making normal quality concrete and adding as much z-shaped copper fiber content that has been twisted. 0%, 0.5%, 1% and 1.5% of the volume of the concrete mix. In the initial planning, the quality of the concrete used is 20 MPa. The specimen is in the form of a concrete cylinder with a diameter of 15 cm and a height of 30 cm. In this research, the test carried out is the compressive strength and split tensile strength of the concrete carried out after the test object is 28 days old.

3. Results and discussions

Test of the coarse and fine aggregate testing conducted in the laboratory to know the characteristics and feasibility of aggregate as materials used in normal concrete constituents. The material of cement and copper fiber did not test, because these materials fulfill the standards. Figure 1. Showing the copper fiber shape used in a mixture in concrete. The surface of the copper fiber is slippery, the shape of the fiber used is Z-shaped with a fiber length of 8 cm which is then folded to meet the two ends after which the fiber is twisted and bent to the two ends of the fiber in opposite direction [1,8-10].

Figure 1. Copper fiber shape.

The concrete test hammer must use the procedure test. Before doing the hammer test, make sure the fineness of the test object because it will affect the result of compression test concrete. The compressive strength test using a hammer test is only done horizontally (0˚). Figure 2. Showing the hammer test graph to determine the compressive strength of the concrete. The hammer test requires a minimum of 9 points to obtain accurate results.

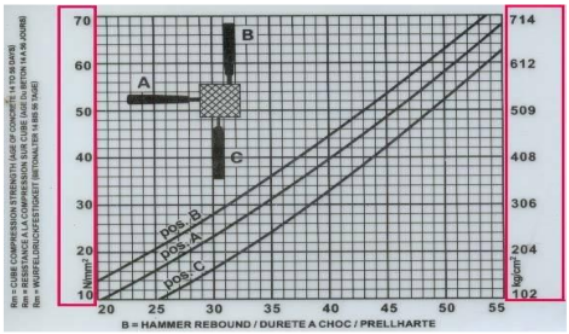

Figure 2. Hammer test chart.

3.1. Concrete compressive strength

The results of the compressive strength test with fiber content of 0,%, 0.5% and 1% have increased with an average normal concrete of 21.06 MPa, the average compressive strength of concrete with a fiber content of 0.5% is 22.19 MPa and the average compressive strength of concrete with a fiber content of 1% was 22.99 MPa, while the copper fiber mixture was 1.5% with an average compressive strength of concrete with a fiber content of 1.5% of 20.99 MPa. the increase in compressive strength at copper fiber content of 0.5% was 5.37% and the increase in compressive strength at 1% copper fiber content was 9.16% and at 1.5% copper fiber content decreased compressive strength by 0.33% (Figure 3).

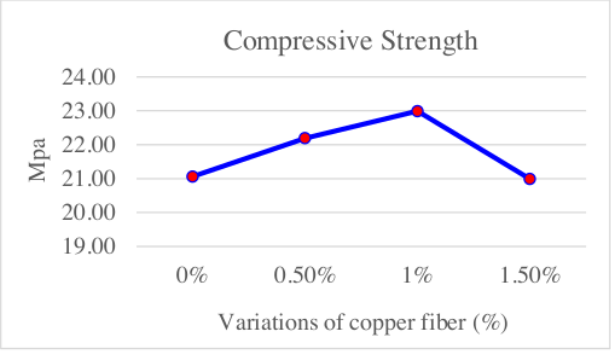

Figure 3. Concrete compressive strength.

3.2. Pull the concrete slice

The results of the split tensile strength test with fiber content of 0,%, 0.5% and 1% have increased with an average normal concrete of 2.31 MPa, the average split tensile strength of concrete with a fiber content of 0.5% is 2, 80 MPa, the average split tensile strength of concrete with 1% fiber content is 2.99 MPa and the copper fiber mixture is 1.5% with an average split tensile strength of 3.06 MPa. increase in split tensile strength in rigid pavement concrete with copper fiber content of 0.5% of 21.21%, increase in split tensile strength with 1% fiber content of 29.44%, increase in split tensile with 1.5% fiber content of 32.46 % with this test, it means that the use of copper fibers in the concrete mixture can increase the tensile strength of the concrete because the copper has been twisted.

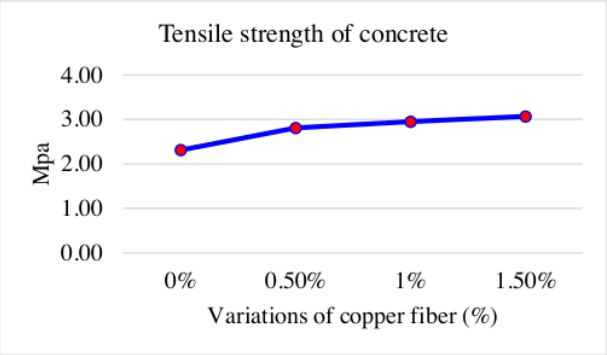

Figure 4. Pull the concrete slice.

Based on figure 4, from the compressive strength value of concrete at 0% fiber content of 21.06 MPa and the split tensile strength of 2.31% (10.99% of the compressive strength of concrete), the compressive strength of concrete at a fiber content of 0.5% is 22.19 MPa and the split tensile strength is 2.8 MPa (12.61% of the compressive strength of the concrete), the compressive strength of the concrete at 1% fiber content is 22.99 MPa and the split tensile strength is 2.95 (12.83% of the compressive strength concrete) and at a fiber content of 1.5% the compressive strength experienced a decrease in compressive strength by 20.99 MPa while the split tensile strength resulted in an increase of 3.06 MPa (14.59% of the compressive strength of concrete).

4. Conclusion

The mixing of copper fibers that have been twisted and bent in a Z shape has a big effect on concrete, especially on the tensile strength of the concrete which increases successively with a variation of 0% fiber of 2.31 MPa, variation of 0.5% fiber of 2.80 MPa., 1% fiber variation is 2.95 MPa and 1.5% fiber variation is 3.06 MPa with these results, the increase in split tensile fiber is 12.61%, 12.83% and 14.59% of the compressive strength of the concrete. The use of copper fiber by twisting the fiber when compared to previous studies without twisting is better because it can increase the tensile strength of concrete.

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