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Compressive and Tensile Strength with the Addition of Rebar Wire Fiber to Pre-placed Aggregate Concrete (PAC)

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***Abstract*—** *Pre-placed aggregate concrete (PAC) is widely used in civil engineering construction. PAC concrete contains a higher percentage of coarse aggregate because the coarse aggregate is deposited directly into the mold. PAC concrete has a higher compressive strength, elastic modulus, and lower shrinkage than conventional concrete. However, PAC has low tensile strength, so it is necessary to look for materials that can increase the tensile strength of the PAC, one of which is rebar wire fiber. The type of fiber used in this research work is straight rebar wire fiber with a diameter (d) of 1 mm and a length (l) of 60 mm. The mortar with a cement-to-sand ratio of 1.0 and a water-to-cement ratio of 0.45 is used as grouting material for filling the voids between coarse aggregate. The compressive and tensile strength tests showed that the addition of 1% rebar wire fiber contributed to the compressive strength and tensile strength of the pre-placed aggregate concrete (PAC). The compressive strength and tensile strength increased by 11.23% and 38.84%, respectively.*

***Keywords*—** *Pre-placed Aggregate Concrete, Rebar Wire Fiber, Compressive Strength, Tensile Strength.*

I. INTRODUCTION

In the construction of infrastructure such as buildings, roads, dams, and canals, concrete is often used as a construction material. Because concrete has many advantages, including easy workmanship, easy-to-find materials, and cheap maintenance, in terms of its structural properties, concrete has great compressive strength. Concrete also has disadvantages, one of which is that it has low tensile strength and is a is a brittle material, so it is very ineffective if concrete is used on structural elements that have a large tensile force.

Along with developments in construction technology, pre-placed aggregate concrete (PAC) is currently widely used. PAC, as defined by ACI 116R, is concrete produced by placing coarse aggregate in a mold and then injecting cement mortar [1]. The special properties of PAC are different from conventional concrete. PAC concrete contains more coarse aggregate because the coarse aggregate settles directly into the form. PAC concrete has a higher compressive strength, elastic modulus, and lower shrinkage than conventional concrete [2–4]. Similar to conventional concrete, PAC also has low tensile strength, so it is necessary to look for materials that can increase the tensile strength of the PAC, one of which is rebar wire fiber.

The use of rebar wire fiber as an additional ingredient in concrete mixture has been carried out by Ngudiyono [5], Sucahyo et al. [6], and Arman et al. [7]. From this researches, it's were found that the use of rebar wire fiber can improve the mechanical properties of concrete (compressive strength, tensile strength, shear strength, flexural strength, and ductility. However, the use of rebar wire fiber as an additional material in PAC has never been carried out. The aim of the research is to determine the effect of rebar wire fiber on compressive strength and tensile strength of the PAC.

II. MATERIAL AND METHOD

A. Material

The materials used in the research are Portland Composite Cement (PCC) of specific gravity 2.83, river sand as fine aggregate with a specific gravity of 2.55, crushed stone as coarse aggregate with a specific gravity of 2.69, and Super-plasticizer (SP), a high-range water-reducing admixture called Sika Viscocrete 3115N with a dosage of 1%. The type of fiber used in this research work is straight rebar wire fiber with a diameter (d) of 1 mm and a length (l) of 60 mm. The sample of the rebar wire fiber is presented in Figure 1. Mortar with a cement-to-sand ratio of 1.0 and a water-to-cement ratio of 0.45 is used as grouting material for filling the voids between coarse aggregate.

Fig. 1. Sample rebar wire fiber.

B. Method

There are two mixes that were considered to investigate the compressive and tensile strengths of preplaced aggregate concrete (PAC) and preplaced aggregate wire fiber reinforced concrete (PAC 1%) and one mix for normal concrete (NC). The percentage of rebar wire fiber used in the study is 1% of the volume of concrete. The mix design of PAC, PAC 1%, and NC was prepared as shown in Table I.

TABLE I. Mix proportion of PAC, PAC 1% and NC per 1 m^3

Mix Type	Wire Fiber (%)	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water (kg)	SP (kg)	Wire Fiber (kg)
PAC	0	469.73	469.73	1207.61	211.38	4.70	0
PAC 1%	1	469.73	469.73	1207.61	211.38	4.70	66.80
NC	0	411.11	620.802	1205.087	185.00	0	0

There are 3 cylindrical specimens (150 mm × 300 mm) in each mixture, so the total number of cylindrical specimens was 9 specimens. The specimen-making process begins with placing coarse aggregate and rebar wire fiber in the mold while placing a pipe inside to be used in the injection process, as shown in Figure 2. The grouting mixture (cement and sand) is subjected to a drying mixing process for 2 minutes using a mortar mixer machine. Then, the mixing water and SP were added gradually to the dry mixture for a duration of 4 minutes, until the mixture reached a state of homogeneity. Furthermore, the mortar mixture is fed into the mold using a plastic pipe using the grouting pumping method until it fills all the voids, as shown in Figure 3. The casting was demolded and placed in a water tank for curing, as shown in Figures 4 and 5.

Fig. 2. Placing Coarse Aggregate and Rebar Wire Fiber in the Cylindrical

Fig. 3. Grouting Pumping Process

All specimens of PAC and PAWFC were measured at 28 days. The compressive strength of the cylindrical specimens was tested according to ASTM C39 [8]. The splitting tensile test of cylindrical specimens was tested in accordance with ASTM C496 [9], as shown in Figure 6.

Fig. 4. Cylindrical Specimens

Fig. 5. Curing Cylindrical Specimens

(a) (b)

Fig. 6. (a) Compressive Strength (b) Tensile Strength

III. Result and Discussion

A. Compressive Strength

The compressive strength test results for PAC, PAC 1%, and NC are presented in Figure 6. According to the figure, it can be seen that the compressive strength of PAC and PAC 1% at 28 days is higher than the compressive strength of NC. The research results show that the compressive strength of NC is 32.272 MPa. Meanwhile, the compressive strengths of PAC and PAC 1% are 32.744 MPa and 36.424 MPa, respectively.

B. Tensile Strength

The tensile strength test results for PAC, PAC 1%, and NC are presented in Figure 6. Based on the figure, the research results show that the tensile strength of NC is 2.642 MPa, while the tensile strength of PAC is 3.092 MPa and PAC 1%

is 4.293 MPa.

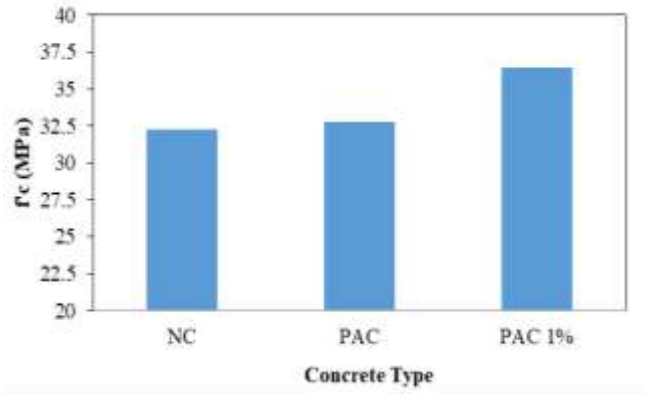

Fig. 6. The compressive strength of PAC, PAC 1% and NC

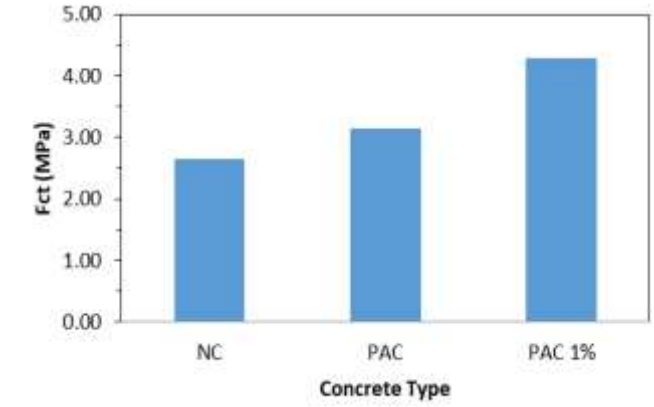

Fig. 7. The tensile strength of PAC, PAC 1% and NC

IV. CONCLUSION

According to the results of the research above, the addition of 1% rebar wire fiber contributed to the compressive strength and tensile strength of the preplaced aggregate concrete (PAC). The compressive strength and tensile strength increased by 11.23% and 38.84%, respectively.

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