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Performance of Concrete Containing Combination of Macro Mesh PP and Nylon Fibers

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Abstract: Fibers are mainly used as substitutes for conventional reinforcement in non-structural applications to monitor early thermal contraction and drying shrinkage cracking. These benefits had increased the application of fibers to structures, especially those with low levels of durability such as grade slabs, foundation and walls. The use of fibers as part of the overall structural architecture increasing from time to time. The addition of an optimum combination of macro mesh polypropylene fibers and nylon fibers in concrete can enhance the strength and make it more durable. Therefore, this study was about to investigate the strength properties of concrete containing polypropylene fiber and nylon synthetic fibers as addition fiber materials. The design addition of fiber which 0.5%, 1.0% and 1.5% for both type of fibers was evaluated. Overall, the fiber reinforced concrete for 1.5% of polypropylene and nylon fiber are the best ratio of mix designation that have significant increase of compressive and tensile strengths compared to control sample. Meanwhile, the density test for concrete containing 1.5% of mix proportion of polypropylene and nylon fiber shows insignificant result compared to control sample.

Keywords: Polypropylene Fibers, Nylon Fibers, Compressive And Tensile Strength

1. Introduction

Concrete is a building material made up of cement, fine aggregates and coarse aggregates combined together with water that usually take times to harden. Portland cement is the typical cement that widely used in the manufacture of concrete. Concrete innovation is concerned with the analysis of the properties of concrete with its functional applications. In the construction of a building, concrete was used for the construction of columns, foundation, slabs, beams and other load bearing elements. Various forms of binding agent are used rather than cement.

The use of natural and artificial fibers is very common in rehabilitation of reinforced concrete

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structures [1]. The concrete with the using of fiber is called Fiber Reinforced Concrete (FRC). FRC is Portland concrete lined with more or less uniformly spread filament. In FRC, thousands of small fibers are scattered and uniformly deposited in concrete during mixing phase thus enhancing concrete properties in all concrete directions. Fiber helps increase post peak ductility efficiency, pre-crack tensile strength and compressive strength of concrete. Several different types of fiber, both artificial and natural, have been incorporated into concrete [2-3].

The result of polypropylene fibers and nylon fiber can also be promising as polypropylene reinforced concrete and nylon reinforced concrete is used for sustainable and long-lasting concrete design. Polypropylene (PP) fibers and nylon fibers are commonly used as reinforced fiber concrete in the world. According to researchers that had done their research, the addition of PP fiber into concrete produces poor workable or insufficient workability for concrete [4].

Nowadays, many structures or buildings that had been constructed have a failure caused by failure of design or natural disaster. The failure that usually occur are bending, buckling, cracks, efflorescence, erosion, spalling and pop outs. This failure occurs because of adding improper amounts of water to theconcrete, low quality of material and improper curing [5-6]. By studying about the improvement that can bemade towards the performance of concrete, this problem can be solved. Concrete itself normally takestimes to gain harden and gain strength but also have their own limit of strength [7]. A study to increase thedurability of concrete by mixing with other elements is very helpful. The purpose of this study is to investigate the performance of concrete containing combination of macro mesh PP and nylon fibers andthe expectations for this study are to produce high strength and workability properties of concrete containing fiber with combination type of fiber promote reuse by-products materials to promote high strength foam concrete in the construction industry.

2. Materials and Methods

Laboratory includes workability, density, compressive strength and split tensile strength had been conducted to find physical and mechanical properties of concrete containing macro mesh PP and nylon as synthetic fibers. The data is analysed to determine the workability, strength and relation strength between compressive and tensile strength had been anaylsed.

2.1 Materials

The materials used in this study are coarse aggregate, fine aggregates, cement, water, polypropylene fiber and nylon fiber. The length for manufactured macro-PP fiber was 45mm and nylon fiber length was 20 mm.

2.2 Methods

FRC mixtures designed according to the British mix design or the Department of Environment mix design revised in 1998. The water-cement ratio used in the concrete mix design is 0.45. The study prepared two types of a sample of a concrete cube with dimension 100mm x 100mm x 100mm (length x width x height) and concrete cylinder with dimension 100 mm x 150 mm (diameter x height).The volume of PP fiber and nylon fiber of 0.5%, 1.0% and 1.5% was determined based on the amount of concrete needed for the casting of cubes and cylinders by considering the mixer capacity.The quantity of concrete would have been increased by 15% of the design mix volume, taking into account the losses that occurred during the mixing process [8]. The concrete cube sample is used for compression test meanwhile the concrete cylinder sample is used for split tensile test. The number of specimens to be tested are 36 samples of both sample and at least three specimens for testing from different batches.

3. Results and Discussion

For this study, the performance of concrete is determined by looking at its workability, density, compression value and tensile value. To obtain this result, several test had been conducted which is

slump test to determine workability of concrete, density test to obtain the density of concrete compressive strength test to obtain compression value and Split-tensile strength test to obtain splitting tension value.

3.1 Density

It can be It can be concluded that, as percentage of PP fiber and nylon fiber are increasing, the density of concrete decreasing. This is because the fiber would absorb water and bind to hold the concrete together thus reducing the density of the concrete. The advantage of increasing the value of fiber is it is lightweight as the fiber are also cheap [9]. The disadvantage of adding fiber in concrete are the density of concrete would be decrease and thus would cause an air voids in the concrete and lower the strength of the concrete itself [10-12]. But after compressive strength test had been done, it shows that the lower of density do not affect the strength of the concrete as the value of compressive strength increasing when the value of fiber are increasing. Figure 1 shows the result obtained based on the testing of sample.

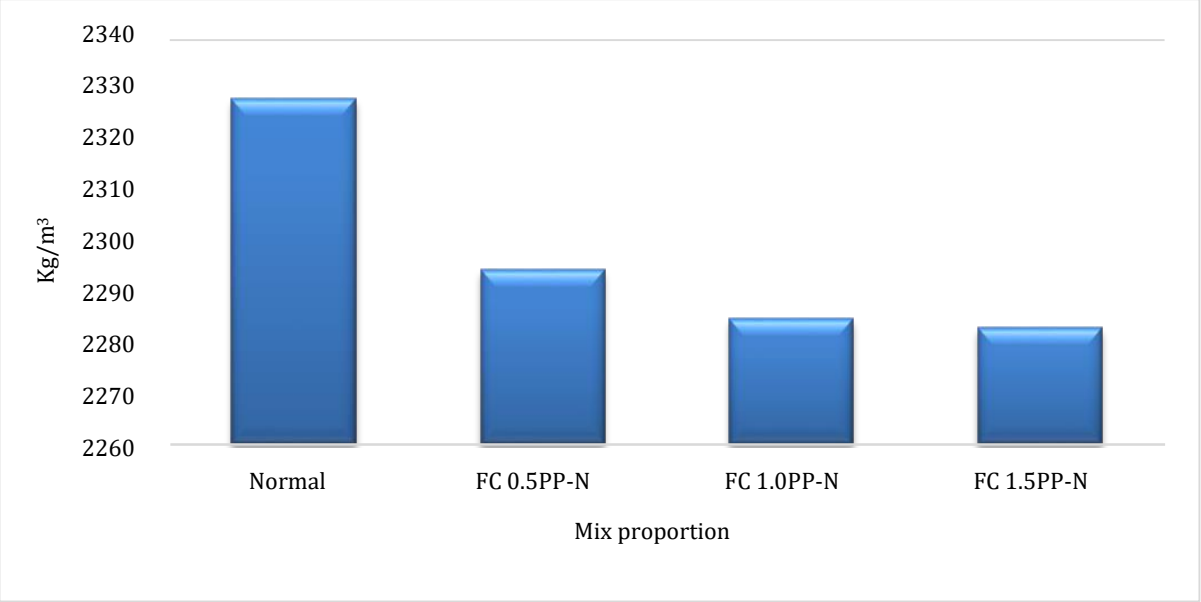

Figure 1: Density for FRC

3.2 Compressive Strength

The experimental results for compressive strength are tabulated in Table 1 and Figure 2. This study shows that instability occurred to the compressive strength of concrete when fibers were added. Therefore, the addition of fibers in concrete does not improve the compressive strength of concrete, which is consistent with the reports by Fraternali et al. [13] and Irwan et al. [14]. Furthermore, in this study, the increment in the compressive strength of FRC was not influenced by the volume of the added fibers.

Table 1: Compressive strength FRC

Mix Designation	Compressive Strength (MPa)
	28 days
Normal	35.63
FC 0.5PP-N	34.13
FC 1.0PP-N	35.39
FC 1.5PP-N	35.99

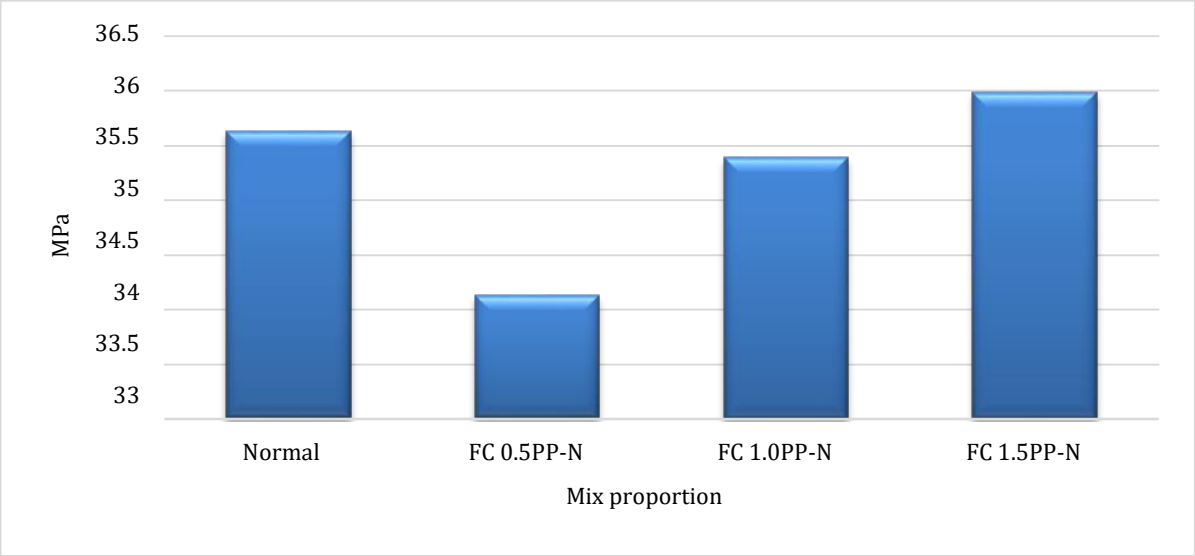

Figure 2: Compressive strength of FRC

3.3 Split Tensile Strength

It can be summarized that as the value of percentage of polypropylene fiber and nylon fiber increase, the tensile strength also increases. This is highly because of the characteristics of both fibers which is contribute to the increasing of tensile strength of the concrete. Even though polypropylene do not affect much on increasing the compressive strength of concrete, is give a big impact on increasing the tensile strength of concrete as shown in Table 2 and Figure 3.

Table 2: Tensile strength of FRC

Mix Designation	Tensile Strength (MPa)
	28 days
Normal	2.81
FC 0.5PP-N	2.92
FC 1.0PP-N	2.91
FC 1.5PP-N	2.93

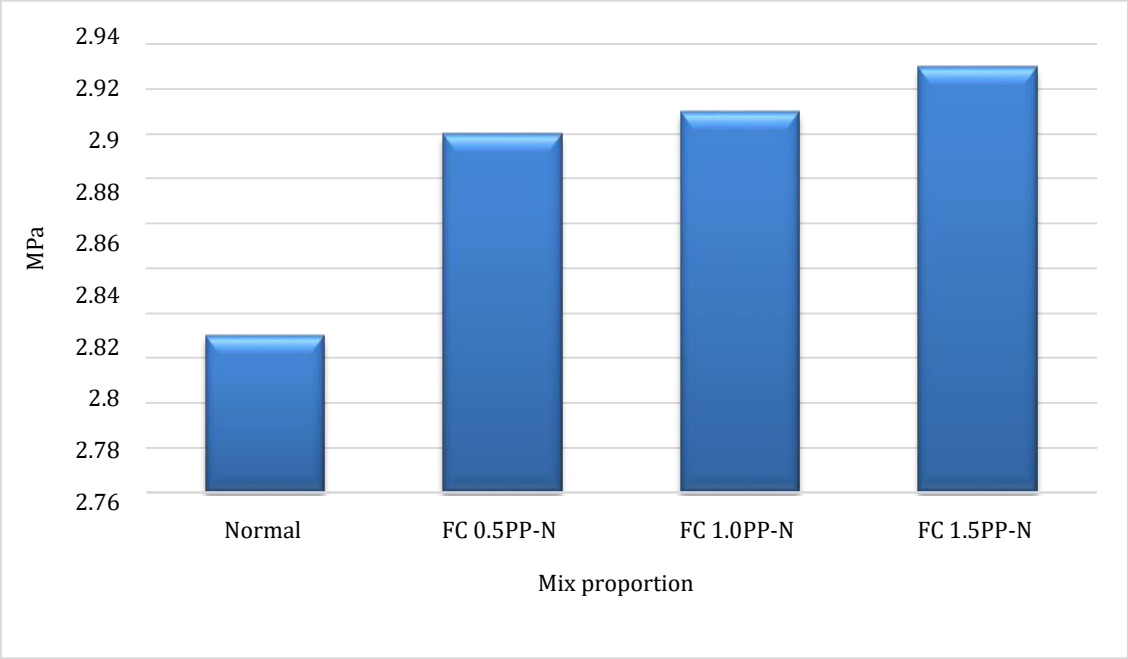

Figure 3: Tensile strength of FRC

This trend This trend of the concrete strength of FRC f implies a gradual increment in tensile strength with increasing fiber content. This finding is consistent with the results reported by Hassan et al. [15], Southos et al. [16] and Khalid et al. [17]. In conclusion, adding fibers, improves tensile strength of concrete. According to tensile strength test, fiber contents of 0.5%–1.5% for both fibers fall within the acceptable working range for FRC reinforced compared to normal concrete.

4. Conclusion

For concrete improvements, there are many research studies that had been done to increase strength, durability and theperformance of concrete itself. Some of the improvement that had been done are by adding some synthetic fiber into the concrete such as nylon fiber, polypropylene fiber, glass fiber and also steel fiber. For this study, the aim was to determine the performance of concrete containing both polypropylene fiber and nylon fiber as synthetic fiber.

This study shows that instability occurred to the compressive strength of concrete when fibers were added. Therefore, the addition of fibers in concrete does not improve the compressive strength of concrete. Splitting tensile strength of FRC is higher compared normal concrete. This result can be ascribed to the interlocking tensile strength of fibers in the fiber-bridging zone and failure until the maximum fiber tensile strength is reached.

Overall, the fiber reinforced concrete for 1.5% of polypropylene and nylon fiber are the best ratio of mix designation that have the highest significant result on tensile strength.

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