EFFECT OF ADDING POLYPROPYLENE FIBERS TO CONCRETE MIXTURES

Lina Flaviana Tilik[1*], Suhadi Suhadi[2], Bastoni Hassasi[3], Sri Rezki Artini[4], Nurul Aina Syahira[5], Tri Kurnia Rahayu[6], Ayu Marlina[7], and Ahmad Riezki[8]

[1-8] Civil Engineering Department, State Polytechnic of Sriwijaya, Palembang, Indonesia
lina_tilik@yahoo.co.id

Abstract. Building constructions found in Indonesia generally use concrete as the main structural material. Even though it has advantages, concrete also has disadvantages in its use, namely that concrete has brittle properties so that it is practically unable to withstand brittle tensile stress. There are many types of fiber that can be used to improve the mechanical properties of concrete, including steel fiber, glass fiber, polypropylene fiber (a type of highquality plastic), carbon and natural fibers derived from natural materials (natural fiber), such as palm fiber, bamboo fiber, coconut fiber, jute fiber and others. One of the unique fiber materials used is polypropylene fiber. The aim of this research is to determine the effect of adding polypropylene fiber on the compressive strength of normal concrete and to find or determine the composition of polypropylene fiber content which causes the optimum compressive strength of concrete. By using FC'30 concrete quality and cylindrical test objects measuring 15 cm x 30 cm, there were 45 test objects. Compressive strength tests were carried out at 7, 14 and 28 days of treatment. From the test results, the normal compressive strength of concrete at 28 days was 30.09 MPa, after using additional polypropylene fiber the compressive strength was 27.73 MPa (0.1% polypropylene fiber), 28.77 MPa (0.2% fiber polypropylene), 27.82 MPa (0.3% polypropylene fiber), and 25.75 MPa (0.4% polypropylene fiber). Based on the test results, it shows that the addition of polypropylene fiber can influence the compressive strength of concrete with a certain level of polypropylene fiber addition, but it still cannot reach the planned compressive strength value.

Keywords: Concrete, Cement, Polypropylene Fiber, Compressive Strength of Concrete

1 Introduction

Building construction development in Indonesia has grown rapidly along with the increasing population, especially in big cities. The need for facilities and infrastructure, especially roads, bridges, houses, and buildings. In general, most of the existing facilities and infrastructure (infrastructure) use concrete construction, the implementation of which is known to most of the public. Concrete can still meet the needs for construction

N. L. Husni et al. (eds.), *Proceedings of the 7th FIRST 2023 International Conference on Global Innovations (FIRST-ESCSI 2023)*, Advances in Engineering Research 232,
https://doi.org/10.2991/978-94-6463-386-3_11

and overall, the cost of concrete construction is considered cheaper compared to other construction.

With the development of technology and knowledge, now a lot of research is being done on concrete quality to get better quality concrete. Concrete is widely used in construction in dams, multi-storey buildings, bridges with long spans, and so on. Among the properties of concrete, the most important are the quality of concrete index and compressive strength.

Innovations in concrete mix research continue to be developed with various kinds of added materials that can increase the compressive strength of concrete. Concrete additives can easily be found around us. Innovation continues to be developed by using various types of waste and various artificial materials that are easily found in nature and easy to process.

A case that often arises in making concrete is the appearance of cracking symptoms caused by tensile stress due to the brittle nature of concrete.

Various types of fibers that can be used to reduce the symptoms of concrete cracks include steel fiber, glass fiber, polypropylene fiber (a type of highquality plastic), carbon and natural fibers derived from natural materials (natural fiber), such as palm fiber, bamboo fiber, coconut fiber, jute fiber and others. One of the unique fiber materials used is polypropylene fiber. This fiber is a fiber that has a low specific gravity and does not absorb water, so this fiber does not significantly change the physical nature of the concrete but can change the mechanical properties of the concrete [7]. The addition of polypropylene fibers to concrete mix is one solution to overcome cracks that may occur due to tensile stress.

This research aims to find out whether concrete with a mixture of polypropylene fiber as an added ingredient can increase the compressive strength of concrete which is higher than normal concrete. So, from the above background, research needs to be carried out to determine the effect of adding polypropylene fibers on the compressive strength of fc'30 concrete.

1.1 Research purposes

The objectives to be achieved in this research:

1. Find out whether additional materials, namely polypropylene fiber, can increase the compressive strength of concrete.
2. To determine the optimum compressive strength of concrete using polypropylene fiber additives at ages 7, 14 and 28 days.

1.2 Limitations of Discussion

1. Polypropylene fiber mixture with a percentage of 0% 0.1%, 0.2%, 0.3%, 0.4%.
2. The slump value remains 60 - 180 mm.
3. Concrete compressive strength testing at 7 days, 14 days and 28 days for all variations of concrete
4. There are 45 cylindrical test objects with a diameter of 15 cm and a height of 30 cm.
5. The fiber used is polypropylene fiber with a size of 12 mm.

2 Research Methodology

Research methodology is a regularly arranged method or technique used to collect data or information in conducting research. The research methodology used in this research is an experimental methodology, carried out by testing materials directly in the laboratory and then making test objects in the form of normal concrete and concrete with predetermined mixture variations.

The concrete test object is made in a cylindrical shape with dimensions of 15 cm x 30 cm. For concrete test objects, an additional mixture of Polypropylene Fiber is used with percentages of 0%, 0.1%, 0.2%, 0.3% and 0.4%.

The material used in this research is coarse aggregate sourced from the Musi II area. Meanwhile, the fine aggregate used in this research was obtained from the Ogan Kayu Agung River. The cement used is type I PPC cement and Polyproplyne fiber. Concrete compressive strength tests were carried out when the concrete was 7, 14 and 28 days old.

3 Results and Discussion

The mixture proportions of the ingredients that make up the concrete are carried out through concrete mix design (job mix formula) guided by SNI 03-2834-2000 concerning Concrete Mix Planning Methods [19]. This is done so that the planned mixture proportions can meet technical and economic requirements.

Comparison of the need for fine aggregate, coarse aggregate, cement and water for 1 m3 is fine aggregate: 598.153 kg/m3, coarse aggregate: 1091.979 kg/m3, cement: 489.13 kg/m3, and water: 195.632 kg/m3 and the need for styrofoam used to make 1 concrete cylinder test object 0% polypropylene: 0 kg, 0.1% polypropylene: 0.028 kg, 0.2% polypropylene: 0.056 kg, 0.3% polypropylene: 0.084 kg, 0.4% polypropylene: 0.084 kg.

From the data from the compressive strength test results of normal concrete and varied concrete, a graph can be made comparing the average compressive strength values of normal concrete based on a predetermined test plan. After reaching the design age, the concrete compressive strength test is carried out at 7 days, 14 days, and 28 days. This test aims to see the difference in compressive strength of normal concrete and variations of concrete with the addition of polypropylene fiber.

The age strength of normal concrete and variation concrete is influenced by the treatment method, for 28 days the concrete has been influenced by weather, temperature, and other natural influences. All concrete experiences an increase in strength from 7 days to 28 days. Concrete variations with the addition of 0%, 0.1%, 0.2%, 0.3% and 0.4% polypropylene fiber experienced a decrease with compressive strength values that were smaller than the compressive strength of normal concrete.

Based on the overall test results for the average compressive strength of concrete at a curing age of 28 days as in Figure 1 and table 1, the compressive strength test results for normal concrete were 30.09 MPa, concrete mixed with BS 0.1% was 27.73 MPa,

BS 0.2 % of 28.77 MPa, at BS 0.3% it was 27.82 MPa, and at BS 0.4% it was 25.75 MPa.

Table 1. Average compressive strength of cylindrical test objects

Test Object Age (Days)	Average Compressive Strength Of Test Objects (MPa)				
	BN	BS 0,1	BS 0,2	BS 0,3	BS 0,4
7	20,18	20,09	23,39	20,84	19,33
14	26,5	25,09	27,07	25,18	23,2
28	30,09	27,73	28,77	27,82	25,75

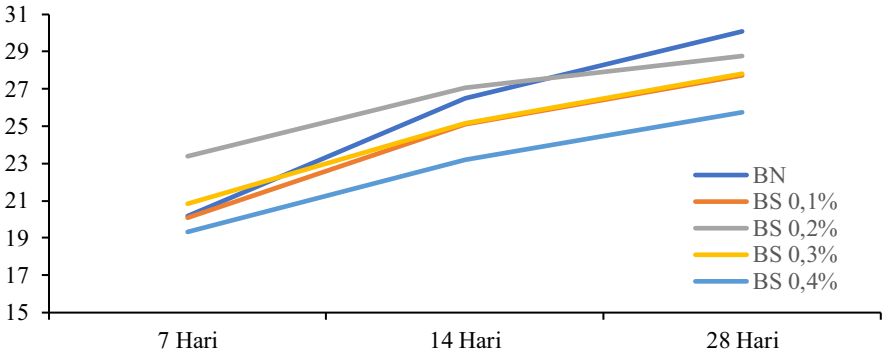

Fig. 1. Graph of Average Concrete Compressive Strength.

The optimum compressive strength obtained from the addition of polypropylene fiber is at a BS percentage of 0.2%, namely 28.77 MPa, when compared with the average compressive strength test results of normal concrete, namely 30.09 MPa, there is a decrease of 1.32 MPa or 4.387% of the compressive strength value of normal concrete for polypropylene fiber mixed concrete. Figure 1 also shows that the compressive strength results of concrete produced at 7 days, 14 days and 28 days have an optimum compressive strength value of 30.09 MPa for normal 28-days concrete and a minimum compressive strength value of 19.33 for concrete with 0.4% polypropylene fiber mixture at 7 days old.

4 Conclusion

From the results of the research, analysis and discussions that have been carried out, the following conclusions can be drawn:

1. From the results of the tests that have been carried out, it was found that the compressive strength value of normal concrete is still much higher than that of concrete with added polypropylene fiber.

2. Based on the compressive strength test of fiber concrete (BS) with each variation, namely BS 0.1%, BS 0.2%, BS 0.3% and 0.4% which was carried out at the age of 28 days, a value of 27 was obtained. 73 MPa, 28.77 MPa, 27.82 MPa and 25.75 MPa. From the results obtained, the compressive strength of BS at 28 days was greatest at 0.2% BS, namely 28.77 MPa. This compressive strength value is 1.32 MPa or 4.39% lower than the compressive strength value of normal concrete at the age of 28 days which is only 30.09 MPa, while other variations at the concrete test age of 28 days have decreased. BS 0.1% experienced a decrease in compressive strength of 2.36 MPa or 7.84% compared to normal concrete, BS 0.3% experienced a decrease in compressive strength of 2.27 MPa or 7.54% compared to normal concrete and BS 0 .4% experienced a decrease in compressive strength of 4.34 MPa or 14.42% for concrete compared to normal concrete.

For citations of references, we prefer the use of square brackets and consecutive numbers. Citations using labels or the author/year convention are also acceptable. The following bibliography provides a sample reference list with entries for journal articles [1], an LNCS chapter [2], a book [3], proceedings without editors [4], as well as a URL [5].

References

1. ASTM Standards. 2004. ASTM C-150-04 Standards Specification For Portland Cement, ASTM International. West Conshohocken, PA.
2. Budi, Aulia. 2020. Analisis Kuat Tekan Beton Mutu Tinggi Pasca Bakar Menggunakan Serat Polypropylene.
3. Faldo, Fransisco. 2021. Pengaruh Efektifitas Penggunaan Serat Polypropylene Terhadap Kuat Tekan Beton Normal
4. Gunawan, Purnawan. 2019. Pengaruh Penambahan Serat Polypropylene pada Beton Ringan dengan Teknologi Foam Terhadap Kuat Tekan, Kuat Tarik Belah, dan Modulus Elastisitas.
5. Hanafi, Muhlis. 2018. Tinjauan Kuat Tekan dan Kuat Lentur Beton Menggunakan Bahan Polymerpolierta dengan Tambahan Pemakaian Fiber Polypropylene.
6. Khairizal, Yuri. Kurniawandy, Alex. Kamaldi, Alfian. (2015). Pengaruh Penambahan Serat Polypropylene Terhadap Sifat Mekanis Beton Normal Proyek. Pekanbaru: Universitas Riau.
7. Mulyono, Tri. (2003). Teknologi Beton. Yogyakarta: Andi
8. Rante, Wira. 2021. Pengaruh Penambahan Serat Polypropylene terhadap Kuat Tekan dan Nilai Permeabilitas pada Beton Berpori.
9. Setiawan, A., 2016. Perancangan Struktur Beton Bertulang (Berdasarkan SNI 1847:2013). Jakarta : Penerbit Erlangga.
10. SNI 03-1968-1990. Metode Pengujian Tentang Analisa Saringan Agregat Halus dan Agregat Kasar. Jakarta: Badan Standarisasi Nasional.
11. SNI 03-1969-1990. Metode Pengujian Berat Jenis dan Penyerapan Air Agregat Kasar. Jakarta: Badan Standarisasi Nasional.
12. SNI 03-1970-1990. Metode Pengujian Berat Jenis dan Penyerapan Air Agregat Halus. Jakarta: Badan Standarisasi Nasional.
13. SNI 03-1971-1990. Metode Pengujian Kadar Air Agregat. Jakarta: Badan Standarisasi Nasional.
14. SNI 03-1972-1990. Metode Pengujian Slump Beton. Jakarta: Badan Standarisasi Nasional.

15. SNI 1972-2008. Cara Uji Slump Beton. Jakarta: Badan Standarisasi Nasional.
16. SNI 03-1973-1990. Metode Pengujian Berat Isi Beton. Jakarta: Badan Standarisasi Nasional.
17. SNI 03-1973-2008. Cara Uji Berat isi, Volume Produksi Campuran dan Kadar Udara Beton. Jakarta: Badan Standarisasi Nasional.
18. SNI 03-1974-1990. Metode Pengujian Kuat Tekan Beton.
19. SNI 03-2834-2000. Metode Perencanaan Campuran. Jakarta: Badan Standarisasi Nasional.
20. SNI 03-4142-1996. Metode Pengujian Jumlah Bahan Dalam Agregat Yang Lolos Saringan No.200 (0,075 mm). Jakarta: Badan Standarisasi Nasional.
21. SNI 03-4804-1998. Metode Pengujian Bobot Isi dan Rongga Udara Dalam Agregat. Jakarta: Badan Standarisasi Nasional.
22. SNI 03-6826-2002. Metode Pengujian Konsistensi Normal Semen Portland dengan Alat Vicat Untuk Pekerjaan Sipil. Jakarta: Badan Standarisasi Nasional.
23. SNI 03-6827-2002. Metode Pengujian Waktu Ikat Semen Portland dengan Menggunakan Alat Vicat. Jakarta: Badan Standarisasi Nasional.
24. SNI 15-2049-2004. Semen Portland. Jakarta: Badan Standarisasi Nasional.
25. SNI 15-2531-2015. Metode Pengujian Berat Jenis Semen Portland. Jakarta: Badan Standarisasi Nasional.
26. Sujatmiko, Bambang. 2018. Pemanfaatan Fiber Polypropylene pada Beton dengan Penambahan Naphtoplast di Tinjau Terhadapat Kuat Tekan dan Kuat Lentur.
27. Tjokrodimulyo, K., 1992. Teknologi Beton. Yogyakarta: Biro Penerbit.
28. Yusra, Andi. 2018. Pengaruh Penambahan Serat Polypropylene pada Kuat Tekan Beton Mutu Tinggi.
29. A. Pnueli, In transition from global to modular temporal reasoning about programs, in: K.R. Apt (Ed.), Logics and Models of Concurrent Systems, Springer, Berlin, Heidelberg, 1984, pp. 123–144.
30. B. Meyer, Applying "Design by Contract", Computer 25(10) (1992) 40–51.
31. S. Bensalem, M. Bogza, A. Legay, T.H. Nguyen, J. Sifakis, R. Yan, Incremental component-based construction and verification using invariants, in: Proceedings of the Conference on Formal Methods in Computer Aided Design (FMCAD), IEEE Press, Piscataway, NJ, 2010, pp. 257–256.
32. H. Barringer, C.S. Pasareanu, D. Giannakopolou, Proof rules for automated compositional verification through learning, in Proc. of the 2nd International Workshop on Specification and Verification of Component Based Systems, 2003.
33. M.G. Bobaru, C.S. Pasareanu, D. Giannakopoulou, Automated assume-guarantee reasoning by abstraction refinement, in: A. Gupta, S. Malik (Eds.), Proceedings of the Computer Aided Verification, Springer, Berlin, Heidelberg, 2008, pp. 135–148.