CIVED Journal of Civil Engineering and Vocational Education

EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Effect of Adding Polypropylene Plastic Waste on Compressive Strength and Flexural Strength Concrete

Tiara Fadila[1*], Sucianti Husnul Khotimah[2], Ignatius Sudarsono[3]
[1,2,3] Civil Engineering, Faculty of Engineering, Universitas Langlangbuana, Indonesia
*Corresponding author, e-mail: tiarafadila80@gmail.com

Received 19th August 2024; Revision 13th September 2024; Accepted 30th September 2024

ABSTRACT

Indonesia is the second largest producer of plastic waste in the world after China with an annual contribution of 187.2 million tons of plastic waste. This study aims to analyze the effect of the addition of plastic seeds with polypropylene substitution on the compressive strength and flexural strength of concrete with the intention of reducing waste waste and utilizing it as a concrete mixing material and making concrete properties into green concrete. The method used is the experimental method by making several variations of concrete mixtures with plastic seeds of polypropylene type as a substitute for part of the sand. The mixing of plastic seeds is divided into several variations, namely, 3% polypropylene seeds and 6% polypropylene seeds. Analysis of the test results of the addition of polypropylene seeds compared to the concrete mixture without polypropylene seeds resulted in a compressive strength of 24.14 MPa for the addition of 3%, as well as a value of 23.25 MPa for the addition of 6% each at 28 days of concrete age. As for the flexural strength, an increase value of 0.16 MPa was obtained for the addition of 6% and the addition of 3% at the age of 28 days. This study shows that the results of the study have reached the planned quality target, namely the quality of fc'20 Mpa.

Keywords: *Polypropylene; Substitution; Compressive Strength; Flexural Strength.*

INTRODUCTION

Indonesia is the second largest producer of plastic waste in the world after China, contributing 187.2 million tons of plastic waste annually. While China reaches 262.9 million tons. [1]. According to the Bandung City Hygiene Office (2021), that the current waste in TPS is still mounting, there are still 50 TPS that are overloaded and 45 TPS that are being handled. It is known that the production of plastic waste is 324.28 m3 / day with a percentage of 18.68%. Plastic is currently a material that is easily found and widely used for many purposes ranging from food packaging to household needs. However, not a few of these plastic materials are difficult to decompose and cannot be recycled easily which can make problems for handling plastic waste in the future and end up polluting the environment, be it land or sea pollution. Polypropylene (PP) plastic is a type of polymer plastic with high mechanical strength and is also one type of plastic that cannot be recycled easily, some examples of money objects made from polypropylene plastic are beverage bottles, plastic packaging containers, bottle caps, straws and many others.

Behind its advantages, plastic waste also causes problems for the environment, namely the nature of plastic is difficult to decompose in the soil. If this condition occurs continuously, it will make

the environment more polluted. One solution to reduce it is by recycling plastic waste, although this method is not very effective in reducing plastic waste.

Partial replacement of sand using polypropylene (PP) plastic waste was used to add 3% and 6% polypropylene plastic to the concrete mix and tested after 7 days, 14 days and 28 days for compressive strength and flexural strength. The purpose of the study was to determine the comparison between normal concrete and polypropylene plastic waste mixture concrete at the same plan quality, namely fc' 20 MPa. Thepurpose of this study is to determine the effect of the addition of polypropylene plastic seeds with a predetermined percentage in the concrete mixture on the compressive strength and flexural strength of concrete. The problem limitation of this research is the addition of polypropylerne mixture, namely with a percentage of 3% and 6%, this research only discussesthe addition of polypropylerner waste mixture to tons and its comparison with normal tons, also this research does not discuss its application and does not examine aspects in terms of ordinary research. Where the benefits of the results of this research are expected to mix into one of the useful innovations and this research can be a reference so that this research can be developed again.

Reviewing from previous researchers that the addition of the percentage of polypropylene plastic waste in the concrete compressive strength mixture decreased by 5.15% in the 5% plastic waste mixture, 6.89% in the 10% plastic mixture and 13.53% in the 15% plastic waste mixture. As for the mixing of plastic waste in the concrete tensile strength mixture, it decreasedby 17.61% in the 5% plastic waste mixture, 24.13% in the 10% plastic mixture and 23.24% inthe 15% plastic waste mixture [2].

The purpose of previous researchers and this study is to determine the effect of the addition of polypropylene plastic seeds with a predetermined percentage in the concrete mixture on the compressive strength and flexural strength of concrete, the difference between this study and previous researchers lies in the quality of concrete used and the tests used.

METHOD

Research Location

This research is located at the Laboratory of the Center for Materials and Engineering Goods (B4T) Jl. Sangkuriang No.14, Bandung City, West Java, 40135.

Data Collection Method

The data collected is primary data conducted by research and produces data in the form of table-shaped values from the test results on each sample.

Data Analysis Method

In the form of data obtained from laboratory results which we then process with Microsoft Excel software until the results are in the form of tables and graphs for the results of the researchthat has been done.

Flow Chart

The method used in the tonne carburizing with the utilization of polyren plastic waste as surbstitursi material in the halurs aggregate is an erxsperrimerntal method, soit snecessaryto havesistermatic procedu for the implementation of the procedu from start to finish in order to

EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

obtain optimal results and to be in line with the work schedule. In this research, a flow chart is used to depictthe squnc, steps, and detailsof the work flow of the procedure planning.

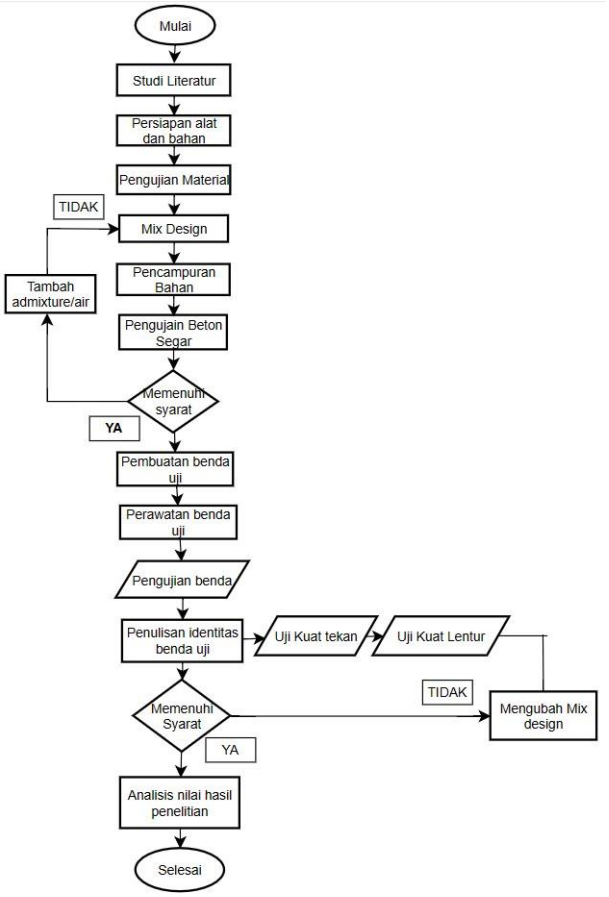

Figure 1. Flow Chart

RESULTS AND DISCUSSION

The results of this study are the acquisition of test data on samples made slump, compressive strength, and flexural strength of concrete.

Slump Test

From the results of fresh concrete testing, the slump value is obtained for each test specimen.

Table 1. Results of Slump Test on Compressive Strength

No	Sample	Date of Manufacture	Concrete Slump Value (cm)		Average
			I	II	
1	BN-T	10/08/2023	8.50	8.50	8.50
2	BPP3%-T	10/08/2023	8.00	9.30	8.65
3	BPP6%-T	11/08/2023	9.00	9.30	9.15

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

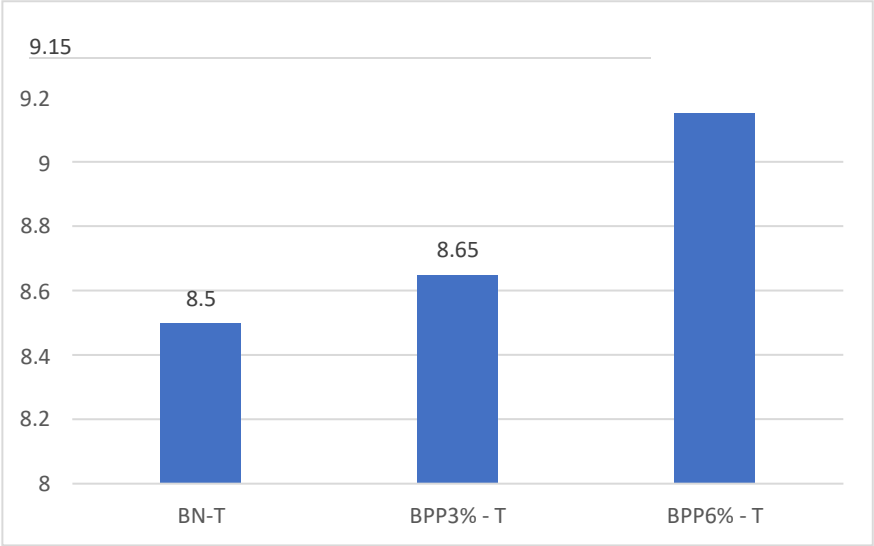

Figure 2: Graph of Compressive Strength Slump Test Values

From the information above, it is known that the average for BN-T samples is 8.5 cm, for average of BPP3%-T of 8.65 cm, and the average for sample code BPP6%-T of 9.15 cm, which means that the average is included in the requirements of the concrete compressive strength test.

Table 2. Results of Slump Test on Flexural Strength

No	Sample	Date of Manufacture	Concrete Slump Value (cm)		Average
			I	II	
1	BN-L	10/08/2023	9	9.5	9
		11/08/2023	8	9.5	
2	BPP3%-L	11/08/2023	8	9.2	9.425
		14/08/2023	10	10.5	
3	BPP6%-L	14/08/2023	9.5	9.5	9.5

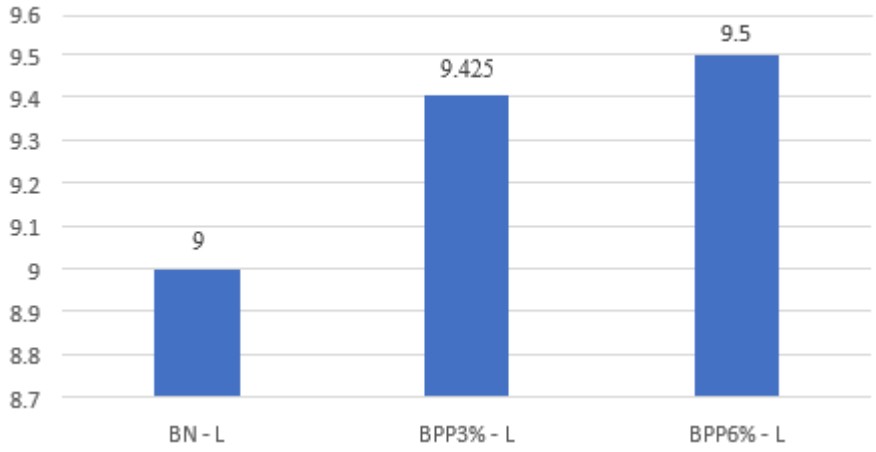

Figure 3: Graph of Flexural Strength Slump Test Values

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

From the information above, it is known that the average for the BN-L sample is 9 cm, for the average of BPP3%-L is 9.425 cm, and the average for the BPP6%-L sample code is 9.5 cm. cm, which means that the average is included in the requirements of the concrete compressive strength test.

Compressive Strength

Before the concrete is tested for compressive strength, it goes through a period of oulding and curing first. For the compressive strength test, in the previous planning the researcher determined the testing age of concrete to be tested at the age of 7 days, 14 days, and 28 days. Testing compressive strength testing was carried out using a Compression Test Machine tool by testing 3 concrete samples from each variation testing 3 concrete samplesfrom each variation. The following are the results of the compressive strength test concretefrom each variation of the Samnpel concrete cylinder variation. The equation used:

$$F'c = \frac{P}{A} \quad \text{.....(1)}$$

Table 3: Average value of combined concrete compressive strength

Age (Days)	Average Concrete Compressive Strength (MPa)		
	Normal	**BPP 3%**	**BPP 6%**
7	19,43	19,74	18,05
14	19,66	21,97	20,43
28	21,74	24,15	23,26

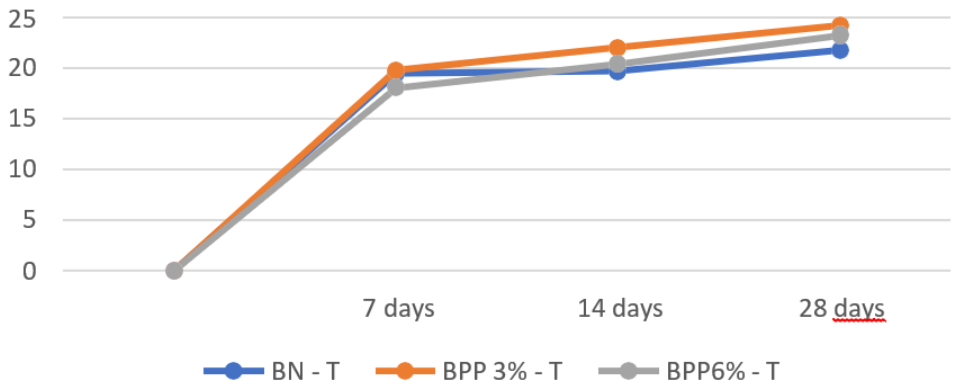

Figure 4: Comparison of Compressive Strength Test Value

For testing the compressive strength at the age of 7 days, the average value of normal concrete is 19.43 Mpa, 3% PP concrete is 19.74 and 6% PP concrete is 18.05 Mpa. So, for the compressive strength test at the age of 7 days, the highest quality is 3% PP mix concrete at 19.74 Mpa. For compressive strength testing at the age of 14 days, the average value of normal concrete Mpa 19.66 Mpa, 3% PP concrete 21.97 Mpa and 6% PP concrete at 20.43 Mpa. For compressive strength testing at the age of 28 days, the most superior value is also in 3% PP concrete with an average value of normal concrete of 21.73 Mpa, 3% PP concrete of 24.14 Mpa and 6% PP concrete at 23.25 Mpa. So, in this compressive strength study it

Journal of Civil Engineering and Vocational Education
EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

can be concluded that Polypropylene plastic seeds can be used to replace sand, which will increase compressive strength. However, the use of plastic seeds more than 3% reduces the compressive strength of concrete.

Flexural Strength

Testing flexural strength is almost the same as compressive strength where concrete that has passed the treatment period, concrete is then tested for flexural strength of concrete carried out on concrete 7 days, 14 days and 28 days using a Compression Test Machine tool by testing 2 concrete samples for each variation. This flexural strength test is to determine the bond between aggregate and cement paste. The equation used in calculating the flexural strength is:

$$\sigma = \frac{P \times L}{b \times h^2} \quad \text{.....(2)}$$

Tabel 4. Average Tensile Strength Value of Composite Concrete

Age (Days)	Average Concrete Flexural Strength		
	Normal	BPP 3%	BPP 6%
7	1,83	2,32	2,97
14	2,19	2,57	2,48
28	1,94	2,41	2,81

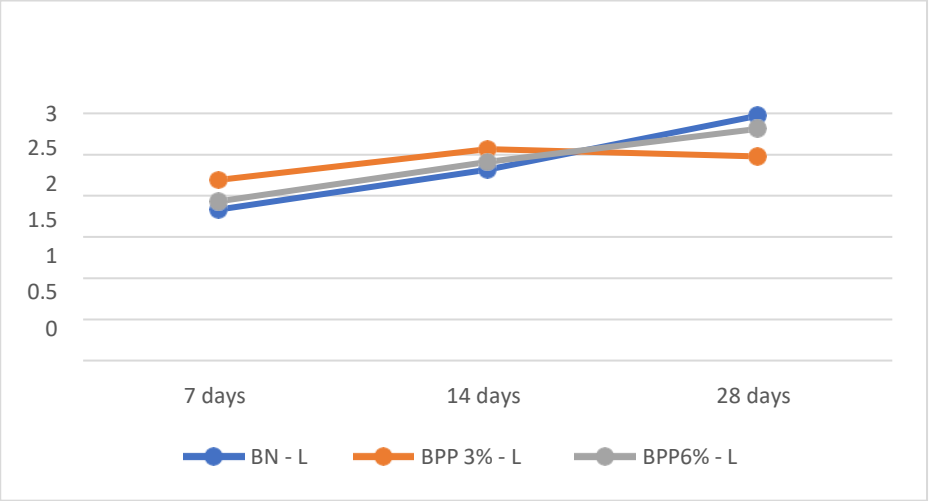

Figure 6: Comparative Value of Flexural Strength Test

From the data above the results of flexural strength testing that the value of flexural strength at the age of 7 days the highest is BPP3% at 2.19 Mpa then 6% PP concrete 1.94 Mpa and Normal Concrete 1.83 Mpa. For compressive strength testing at the age of 14 days, the average value of normal concrete is 2.32 Mpa, 3% PP concrete is 2.57 Mpa and 6% PP concrete is 2.41 Mpa. And for Flexural Strength Testing at the age of 28 days the average in normal concrete is 2.97 Mpa, 3% PP concrete is 2.48 Mpa, 6% PP concrete is 2.81 Mpa. So the conclusion of flexural strength testing at the age of 28 days can be concluded that normal concrete is superior to mixed concrete.

- The relationship between compressive strength and flexural strength of concrete
  For this study, it was found that the variable X and variable Y have a strong relationship

EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

obtained from the correlation value, it can be seen that there is a positive linear correlation relationship where the variable x moves in the direction of moving up with the variable y. and the value of r = 0.735 is obtained. The table is known for the range 0.60-0.799 indicating that the correlation is strong. This means that the relationship between the two variables shows a positive relationship, the value of r itself is obtained from the value of the results of research on the compressive strength and flexural strength of concrete which is then processed using a linear correlation equation. The empirical formula used is:

σ = 0,7 x √fc′ ..... (3)

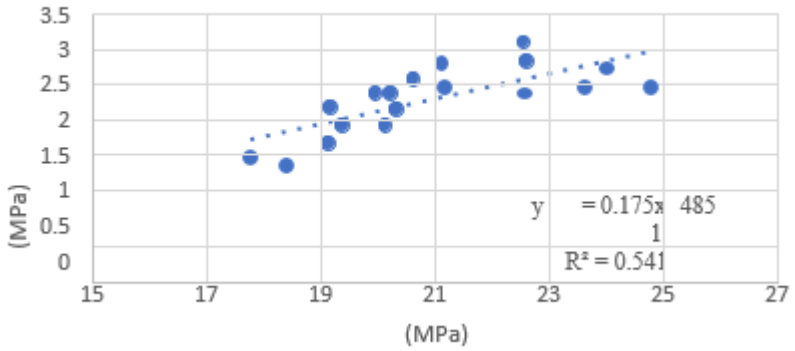

Figure 7: Relationship between compressive strength and flexural strength

Compressive Strength

The effect of using polypropylene (PP) plastic waste on concrete compressive strength, prepared by Angga Pirman. Concrete compressive strength is the amount of load per unit area that causes a tonne test specimen to be destroyed when loaded with a certain force produced by a compressive testing machine. tonne compressive quart is an illustration of concrete quality, because usually an increase in tonne compressive strength will befollowed by an improvement in other concrete properties. The test object used in this test is a cylinder with a size of Ø 10 cm and a height of 20 cm as many as 3 pieces for each variation. This test aims to determine the ability of tons with a mixture of polypropylene (PP) plastic waste to receive loads. Tests were carried out at the age of 3, 7 and 28 days (Angga, 2017).

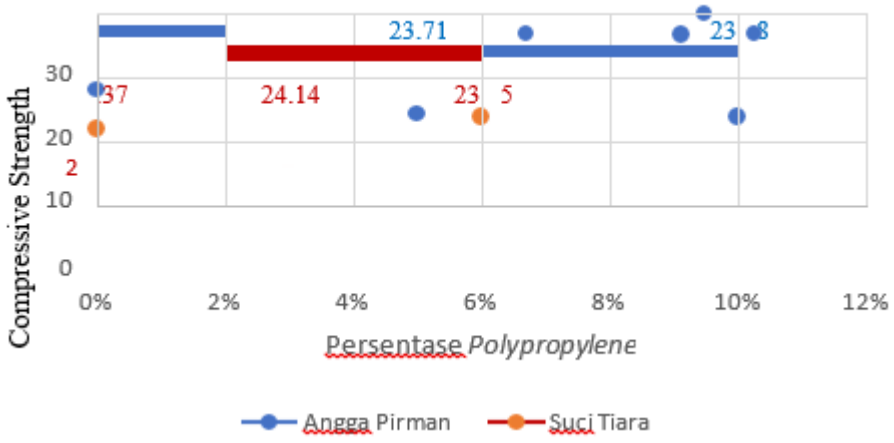

Figure 8. Comparison of Compressive Strength

Flexural Strength

"Changes in flexural, tensile and impact characteristics of kerb concrete due to the additionof tyrer-derived aggregates and polypropylene fibres" is an international journal by HasanMomtaz,

EISSN: 2622-6774
Vol 11 No.3 September 2024
http://cived.ppj.unp.ac.id/index.php/CIVED

Md. Mizanur Rahman, Md. Rajibul Karim, Yan Zhunger, Xing Ma, and Petterr.

Lervertt contains a discussion of the addition of PPF (Polypropyelene Fiber) to tons (2024).In this research with our research there are differences that lie in the quality of concrete andthe type of plastic addition. Hasan's research uses concrete quality fc'25 MPa while our research with quality fc' 20 MPa. In addition to the concrete quality, there is also a difference in the type of plastic addition, namely polypropylene fibres and our research uses polypropylene seeds.

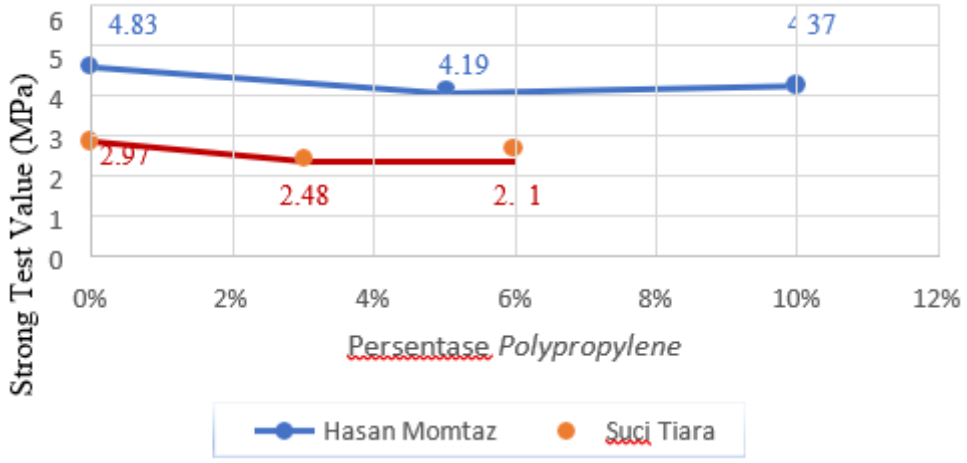

Figure 9: Comparison of Flexural Strength

CONCLUSION

Based on the research conducted:

1. The addition of polypropylene plastic seeds has no effect on the increase in strength, which is superior to normal concrete with 0% plastic seed content.
2. The test results of the compressive strength of 3% polypropylene seeds increased by 2,44 Mpa compared to normal concrete. As for the flexural strength, normal concrete is still superior compared to mixed concrete, which is 0.16% different from the value of 6% pp concrete mix.
3. From the comparison of the research graphs, it can be concluded that if the greater the percentage of polypropylene mixture, the more the strength of concrete decreases.

REFERENCE

[1] Angga Pirman Firdaurs, & Jonbi. (2019). Effect of using polypropylene (Pp) plastic waste as coarse aggregate admixture on compressive and tensile strength of concrete with Fc' 25 Mpa. Journal of Infrastructure.

[2] Pratama, K. I., Naibaho, P. R. T., & Bangun, S. (2023). The relationship between compressive strength and flexural strength of concrete with quality Fc' 25 Mega Pascal (MPa). Indonesian Journal of Construction Engineering and Sustainable Development (Cesd), 6(1), 1-7.

[3] Savira, F., & Suhasono, Y. (2013). Definition of Influence, Motivation. Journal of Chemical Information and Modelling, 01(01), 1689-1699.

[4] Danar Kurrniawan, B. S., A. P.,. (2015). Behaviour of compressive and tensile strengthof HDPE plastic waste mix concrete. Semesta Teknika, 16(1), 76-82.

[5] Kartini, W. (2019). Use of Polypropylene Fibre to Increase the split tensile streng concrete. Engineering Planning, 4(1), 1-13

[6] Puja, N., Agustriana, V., & Irianti, L. (2020). Effect of Addition of Steel Fibre and Polypropyleneibre on the Compressive Strength and Flexural Strength of Concrete. Journal of Civil Engineering and Design, 8(4), 681-692.

[7] Ridwan, F. F., Subari, & Elma, Y. (2014). Effect of Polypropylene (Pp) Plastic Glass Shreds on the Compressive Strength and Tensile Strength of Concrete, 2(1), 24-37.

[8] Risayanti, R., Triwahyudi, R. N., & Anggraini, R. (2023). Analysis of compressive and flexural strength values of added polypropylene fibre curved form in normal concrete mix. Unbari Civonlit Journal, 8(2), 99.

[9] Sudarsono, I., Wahyudi, S. I., & Adi, H. P. (2023). *Fly Ash and Silica Fume Substi tuti on Compressive Strength and Permeability of Concrete in the Marine Environment. Jurnal PenSil*, *12*(3), 281–292.

[10] Sudarsono, I., Wahyudi, S. I., & Adi, H. P. (2023). *Fly Ash and Silica Fume Substitution on Compressive Strength and Permeability of Concrete in the Marine Environment. Jurnal PenSil*, *12*(3), 281–292.

[11] Hasan Momtaz, M.M (2024, January). *Changes in flexural, tensile and characteristicsof kerb concrete due to the addition of tyre-derived aggregates and polypropylene fibres. Journal of Building Engineering* 83 (2024) 108438.