Correlation of Compressive Strength of Cylindrical Specimens with Reinforced Concrete Slabs Cast in the Field

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Abstract. The concrete construction work process usually has many factors that influence the quality of the concrete, starting from various methods of preparing materials to caring for the concrete. This occurs because of the differences in treatment given to samples in the laboratory and workpieces made in the field. This research aims to determine the comparison of the compressive strength of concrete in the field and in the laboratory with various treatment methods using hammer tests on reinforced concrete plate specimens cast in the field and a compressive strength testing machine on cylindrical specimens in the laboratory. This research used cylindrical test objects and reinforced concrete plates measuring 2 m x 1 m x 0.1 m. Compressive strength tests were carried out at 3 days, 7 days, 14 days and 28 days, where the concrete was treated and not treated. The results of testing the compressive strength of concrete aged 28 days show that normal laboratory concrete with treatment has the highest average compressive strength value, namely 30.370 MPa. The lowest compressive strength value was produced by normal field concrete without treatment with an average compressive strength of 20,940 MPa. At the age of 28 days, the compressive strength value of the treated reinforced concrete slab produces a reflection value against the reinforcement of 31,140 MPa and 31,260 MPa for the reflection value without reinforcement, while the compressive strength value at the age of 28 days for the concrete plate without treatment is 21,540 MPa for the reflection value.

Keywords: Correlation, Concrete Quality, Compressive Strength.

1 Introduction

Concrete is a construction material commonly used for buildings, roads and bridges, and is made from a combination of aggregate and cement binder. Frequently checking concrete compressive strength tests in the field uses a non-destructive test method, namely a hammer test, because it is relatively more efficient than having to take concrete samples and take them for laboratory tests. In reality, in the field, the hammer test is used to determine whether a test object has uniform or precise quality. If a non-uniformity in the reading value of the reflection number is found in the hammer test, a

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core sample is taken from the test object for testing in the laboratory regarding its suitability and quality or compressive strength testing [1].

Hammer test compressive strength and concrete compressive strength tests have different results and have an uptrend line, which means that the higher the concrete compressive strength, the hammer test compressive strength value is also higher. By using a non-destructive test method by connecting compressive strength with compressive strength, the hammer test can be used as an initial indication of checking structural strength and quality control in the field [2]. There are several forms of compressive strength testing methods that can be used, including non-destructive testing and testing that damages the entire component being tested (destructive testing). This damage test is closest to the actual compressive strength value of concrete, where this test must be carried out in a laboratory using a compression testing machine [3].

However, there are some cases where it is not possible to test concrete samples in the laboratory or some cases where it is necessary to read the concrete compressive strength directly in the field. Cases like this use non-destructive tests. The results of this test do not represent the strength of a structure, so a relationship/correlation with other compressive strength tests is needed. The characteristic strength of concrete during planning and implementation is generally the result of the compressive strength test of cylinder or cube concrete in the laboratory, so in this research we will try to relate the results of concrete compressive strength testing in the laboratory using a compression testing machine and non-destructive testing using a hammer test tool. The aim of this research is to determine the value and relationship between compressive strength using a hammer test and a compression testing machine [4].

Testing the concrete structure after the concrete has hardened is very important, this is done to find out whether the structure is in accordance with the design that has been carried out. There are several forms of concrete compressive strength testing methods that can be used, including non-destructive tests, semi-destructive tests and those that damage all components being tested (destructive tests). This damage test is closest to the actual compressive strength value of concrete, where this test must be carried out in a laboratory using a compression testing machine. However, the results of this non-destructive test method cannot represent the strength of a structure, so a relationship/correlation with other compressive strength tests is needed [5].

This research was conducted to provide correlation values for the results of concrete compressive strength testing in the laboratory using a compressive strength machine and non-destructive testing using a hammer test. From this correlation value, it can be used to determine the compressive strength value of concrete if destructive tests cannot be carried out, thereby increasing the application of the NDT (hammer test) method in Indonesia. So you can easily find out the structural quality of a building [6].

2 Introduction

This research uses cylindrical test objects with a diameter of 15 cm and a height of 30 cm. Compressive strength tests were carried out at 3 days, 7 days, 14 days and 28 days, where the concrete was treated and untreated. The treatment used in the research used jute sacks. Table 1 explains the number of concrete cylinder samples that will be made for testing concrete compressive strength.

Table 1. Number of Cylinder Samples

No	Code	Number of Test Objects	Type of Test Objects
1	BN 1	12	Laboratory concrete with curing
2	BN 2	12	Field concrete with curing
3	BN 3	12	Field Concrete without curing
Amount		36	

Figure 1. Cylindrical Test Object and Reinforced Concrete Plate Test Object

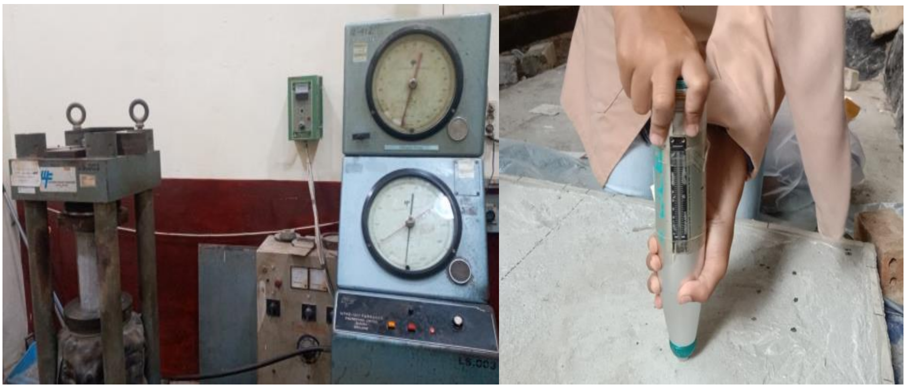

Figure 2. Laboratory Concrete Compressive Strength Testing and Testing of Reinforced Concrete Slabs Using Hammer Test

In this study, apart from cylindrical concrete test objects, there were also test objects in the form of concrete plates with reinforcement in the form of plain iron with a diameter of 10 mm which had dimensions of 2 m x 1 m x 0.1 m. Testing uses a hammer test on reinforced concrete plate specimens printed in the field and a compressive strength testing machine on cylindrical specimens in the laboratory.

3 Result and Discusssion

3.1 Test Result

The results of the concrete hammer test compressive strength readings in the research were obtained from firing the concrete during the concrete rebound number test, while the compressive strength test results were obtained from the cross-sectional area of the test object (mm^2) and the maximum load (N) of each test object.

3.1.1 Test Results for Compressive Strength of Cylindrical Concrete

The compressive strength test of cylindrical concrete was carried out on test specimens aged 3 days, 7 days, 14 days and 28 days with the planned concrete quality of fc' 22.5 with a total of 36 cylindrical samples treated and without treatment. The compressive strength results can be seen in table 2 below.

Table 2. Results of compressive strength of concrete cylinders

Age (Days)	BN1-Compressive Strength (MPa)	BN2-Compressive Strength (MPa)	BN3-Compressive Strength (MPa)
3	16,12	15,75	12, 64
7	20,18	17,92	17,45
14	25,75	20,56	19,52
28	30,37	23,32	20,94

3.1.2 Test Results for Compressive Strength of Reinforced Concrete Plates

Concrete compressive strength testing was carried out on test objects aged 3, 7, 14 and 28 days with the planned concrete quality, namely fc' 22.5 with objects measuring 2 x 1 x 0.1 m, some of which were treated and some were without treatment. Results data Hammer testing is as follows:

Table 3. Average Reflective Value of Field Concrete Slabs with Treatment

	3 days	7 days	14 days	28 days
Average Reflective Value is Not Affected by Reinforcement	18,83	19,08	22,00	27,08
Average Reflection Value Exposed to Reinforcement	20,20	21,60	22,27	30,67

Table 4. Average Reflective Value of Field Concrete Slabs Without Treatment

	3 days	7 days	14 days	28 days
Average Reflective Value is Not Affected by Reinforcement	15,08	16,42	17,25	24,08
Average Reflective Value Subject to Reinforcement	15,08	16,40	17,33	24,53

3.2 Discussion of test result

3.2.1 Compressive Strength of Cylindrical Concrete

Based on the data from normal concrete compressive strength testing results, a graph of the average compressive strength value of normal concrete at the age of 3 days, 7 days, 14 days and 28 days was created as shown in Figure 3.

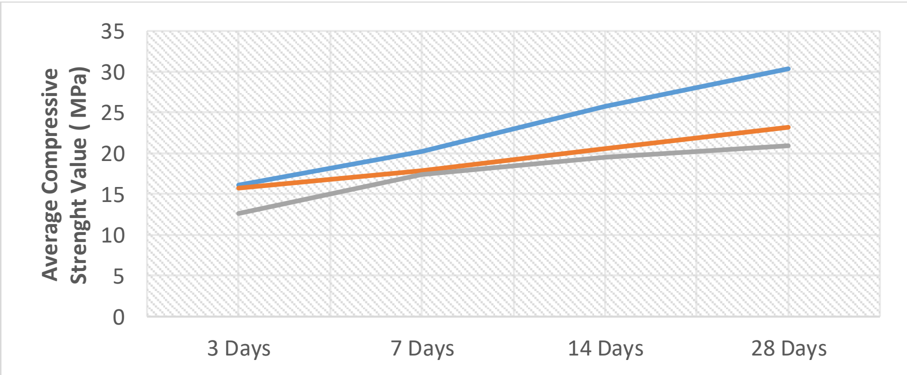

Figure 3. Comparison graph of average compressive strength results for concrete with different treatments

All concrete experienced an increase in compressive strength from 3 days to 28 days, while untreated concrete experienced an increase but was still below the compressive strength value of treated concrete. However, at the age of 3 days, the quality of each concrete did not show any difference because the concrete was still wet and still in the hardening process.

The compressive strength of concrete at 28 days shows that normal laboratory concrete by immersion in water still has the highest average compressive strength value, namely 30.37 MPa. Normal field concrete with treatment has an average compressive strength value of 23.2 MPa and the lowest compressive strength value is at 28 days. Produced by normal field concrete without treatment with an average compressive strength of 20.94 MPa. From these calculations, when compared with the results of the average compressive strength test of normal laboratory concrete, which is

30.37 MPa, there is a decrease of 7.17 MPa or a value of 23.61% of the normal field compressive strength value of concrete with treatment and 9.72 MPa or 32.02% of the normal field compressive strength value of concrete without treatment.

The results of this research show that treatment by covering the concrete with burlap sacks and regular watering provides higher strength with increasing time (durability). It is possible to maintain temperature stability and changes in humidity inside and outside the concrete because the concrete is protected from contamination by external influences, while the hydration process can run well by watering regularly. In the field, both treatment methods by watering and covering with wet burlap sacks can be carried out, apart from maintaining the quality of the concrete, it also increases the strength of the concrete as the age of the concrete increases, while concrete immersion treatment is best carried out in the laboratory.

3.2.2 Compressive Strength of Reinforced Concrete Slabs

This test aims to see the difference in compressive strength of concrete slabs with treatment and concrete slabs without treatment, both for points that are towards reinforcement and not towards reinforcement, the difference in the average reflection value of hammer measurements and the difference in increase or decrease by what percentage in the graph and table below.

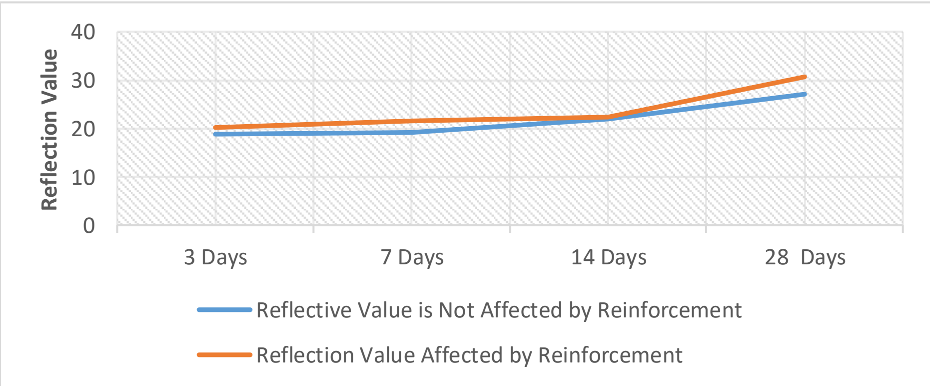

Figure 4. Comparison graph of the average reflection value of field concrete slabs with maintenance

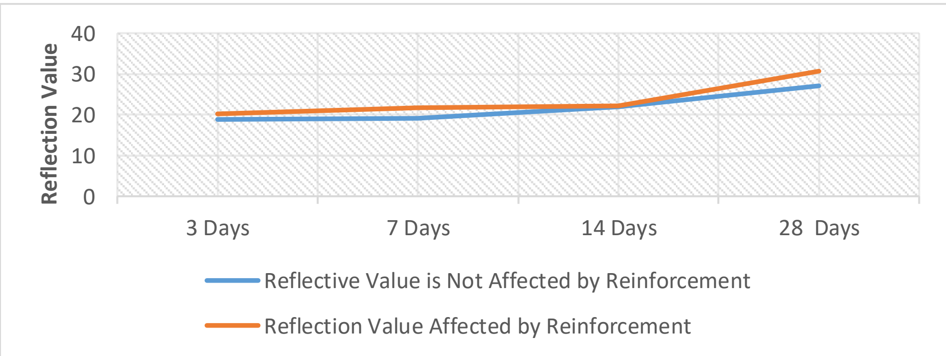

Figure 5. Comparison graph of the average reflective value of field concrete slabs without treatment

Next, the average reflection value is connected to the compressive strength value of the concrete cylinder in a relationship graph to produce a regression equation as follows:

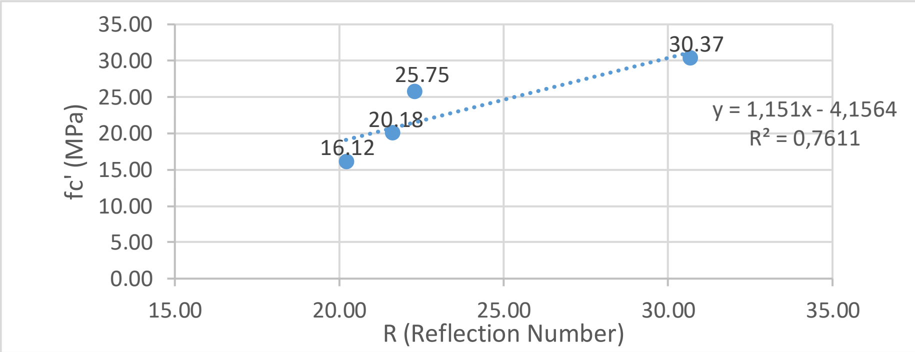

Figure 6. Graph of the Relationship Between R (Reflective Value) Leading Reinforcement and Fc' of the Cylinder with Laboratory Treatment

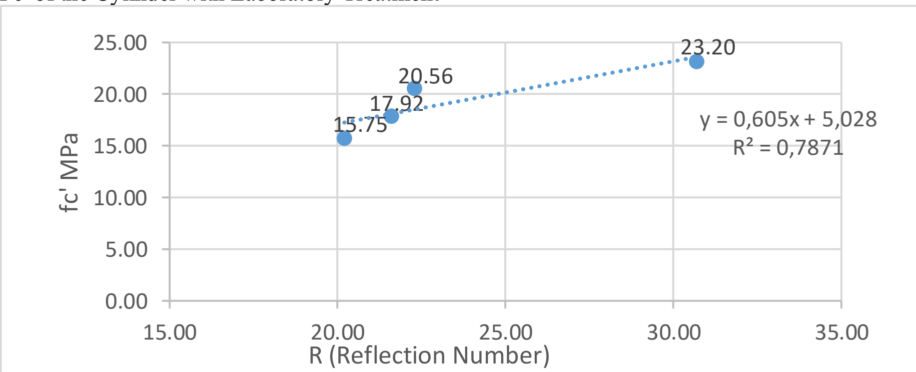

Figure 7. Relationship between R (Reflection Number) Leading Reinforcement and fc' Field Maintenance Cylinder

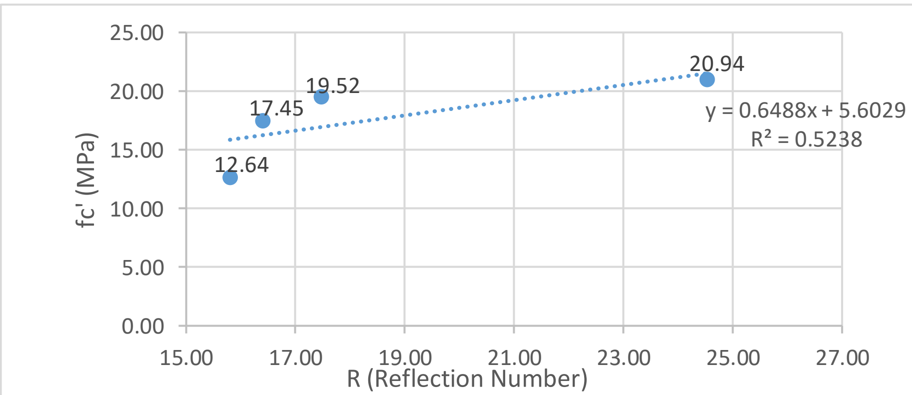

Figure 8. Relationship between R (Reflection Number) Leading Reinforcement and fc' Field Cylinder Without Treatment

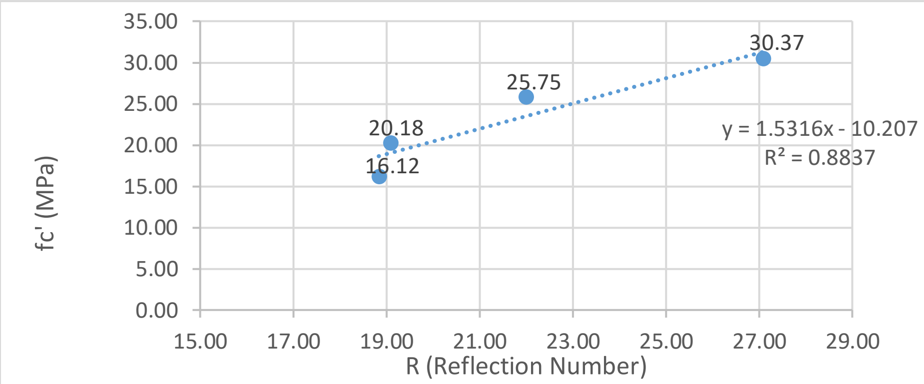

Figure 9. Relationship Between R (Reflection Number) Not Directing Reinforcement and fc' of Cylinder with Laboratory Treatment

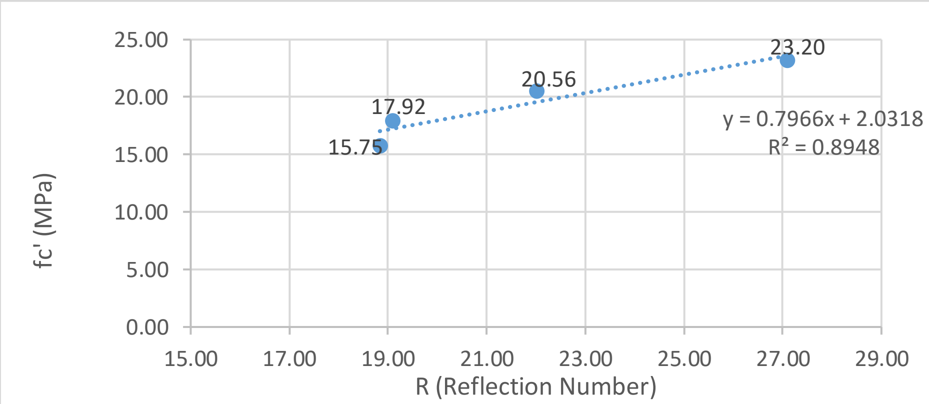

Figure 10. Relationship between R (Reflection Number) Not Directing Reinforcement and fc' Field Maintenance Cylinder

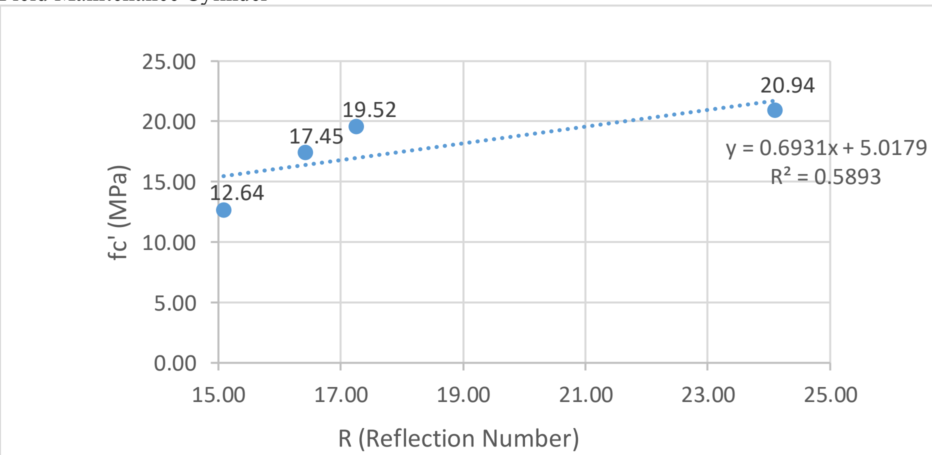

Figure 11. Relationship between R (Reflection Number) Not Directing Reinforcement and fc' Field Cylinder Without Treatment

From this graph, connecting the hammer rebound test number (R) with the fc' value (MPa) of the concrete cylinder produces the equation y = 1.151x – 4.1564 for treated concrete slabs, the rebound value directs the reinforcement to the concrete cylinder treated in the laboratory , y = 0.605x + 5.028 for treated concrete slabs, reflective value directs reinforcement with treated concrete cylinders in the field, y = 0.6488x + 5.6029 for untreated concrete slabs, reflective value directs reinforcement with cylinders untreated concrete, y = 1.5316x - 10.207 for treated concrete slabs the reflection value does not lead to reinforcement with concrete cylinders treated in the laboratory, y = 0.7966x + 2.0318 for treated concrete slabs the reflection value does not lead in reinforcement with concrete cylinders treated in the field and y = 0.6931x + 5.0179 for concrete slabs without treatment, the reflectance value does not cause reinforcement with concrete cylinders without treatment. After the x value in the form of a reflection number is entered into the regression equation, the compressive strength value of the concrete slab (fc' equation). Based on the data on the compressive strength of concrete plates in table 4.35, a comparison graph of the compressive strength values of concrete plates is made based on the equation (fc' equation) as follows Table 5.

Table 5. Compressive Strength of Concrete Plate Based on Eq

Test Object Age (Day)	Compressive Strength of Test Objects (MPa)			
	Concrete Plate (Maintenance)		Concrete Plate (Unattended)	
	Reflection Value Leading to Reinforcement	Reflective Value Does Not Direct Reinforcement	Reflection Value Leading to Reinforcement	Reflective Value Does Not Direct Reinforcement
3	19,09	18,63	15,85	15,47
7	20,71	19,01	16,24	16,40
14	21,47	23,48	16,85	16,97
28	31,14	31,26	21,54	21,71

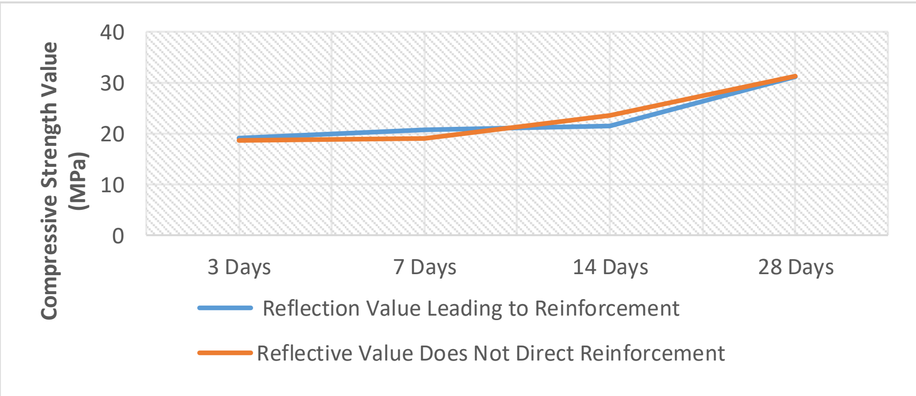

Figure 12. Comparison graph of compressive strength values based on the concrete plate equation with treatment

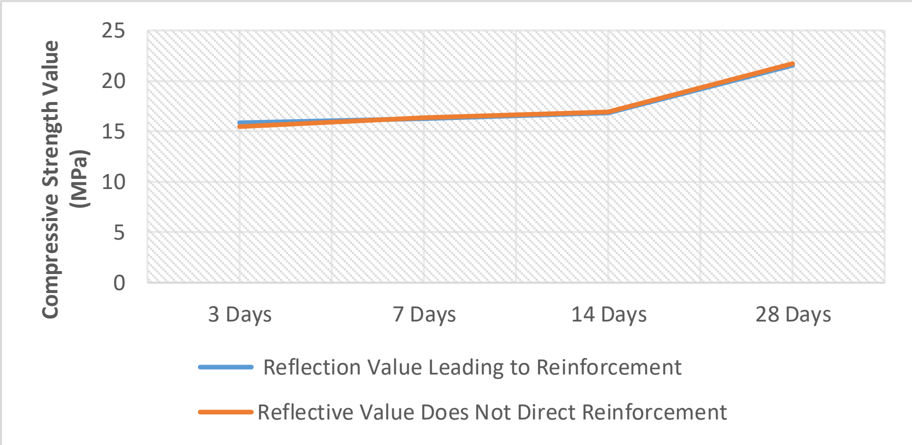

Figure 13. Comparison Chart of Compressive Strength Values Based on the Equation for Concrete Plates Without Treatment.

4 Conclusion

Based on the result of testing and analysis, it can be concluded:

1. The average value of compressive strength of concrete cylinders with treatment in the field is 23.2 MPa and the average value of concrete cylinder samples without treatment is 20.94 MPa, for the 28 day test this average value is still below the sample compressive strength concrete cylinder with laboratory treatment is 30.37 MPa. This average value decreased by 23.61% for field concrete with treatment and 32.02% for field concrete without treatment when compared with the average value of compressive strength of concrete cylinder samples with treatment in the laboratory.
2. The compressive strength value of the concrete plate has increased but the increase in the concrete plate without treatment is still below that of the concrete plate with treatment, at 28 days the compressive strength value of the concrete plate with treatment, the reflection value towards the reinforcement is 31.14 MPa and 31.26 MPa for The reflective value is not towards the reinforcement, while the 28 day compressive strength value of the concrete plate without treatment is 21.71 MPa for the reflective value towards the reinforcement and 21.54 MPa for the reflective value not towards the reinforcement.
3. Based on the data that has been processed, it can be seen that there is a difference in the reflectance value on the 28th day for points that lead to the reinforcement and points that do not lead to the reinforcement. For the concrete plate section with treatment, the reflectance value experienced a significant increase, namely 13.26%, while for Concrete plates without treatment increase by only 1.87% of the percentage increase. It can be seen that the position of the hammer test point

which is towards the reinforcement produces a reading value reflection that is greater than the position of the point that is not directed towards the reinforcement.

4. The relationship between the compressive strength value of a concrete cylinder sample using a compressive strength testing machine and the compressive strength value of a reinforced concrete plate using a hammer test is shown by the equation contained in the graph of the relationship between R (reflection number) and fc' of the cylinder where the R^2 value for the concrete plate is treatment ranges from 0.7611 to 0.8948 while for concrete slabs without treatment it ranges from 0.5238 to 0.5893. From the R^2 value, it can be concluded that the correlation between reinforced concrete plate samples and concrete cylinder samples with treatment is very strong, while for reinforced concrete plate samples and concrete cylinder samples without treatment is moderate.

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