

COMPRESSIVE STRENGTH ANALYSIS OF CONCRETE USING ASPHALT SCRAP WASTE

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ABSTRACT

Concrete is one of the most commonly used building materials in civil construction and is widely used by various groups. Currently, the rapid growth of the global economy has led to various upgrades of concrete building construction systems in various places, resulting in an increase in concrete production. With the development of technology in concrete, more and more ideas and innovations are used to improve the quality of concrete, one of the innovations is by adding additional or substitute materials to concrete. One of the substitute materials that can be used is asphalt scrap waste. This study aims to determine the compressive strength of concrete by utilizing asphalt scrap waste as a partial substitute for coarse aggregate. This research was conducted by comparing the effect of using scrap asphalt waste on the compressive strength of normal concrete. This research method is by conducting experiments or experiments in the concrete laboratory. This research refers to SNI-03-2834-2000, about Procedure for Making Normal Concrete Plan. Based on the research results, it can be concluded that the average normal concrete compressive strength value is 25.57 MPa, so it meets the planned concrete compressive strength of 25 MPa. The average concrete compressive strength of 5% scrap asphalt waste variation is 24.88 MPa, the average concrete compressive strength of 10% scrap asphalt waste variation is 23.86 MPa. Based on these results, that the greater the use of scrap asphalt waste, the compressive strength of concrete decreases.

Keywords: Waste, asphalt scrap, coarse aggregate, compressive strength, concrete

INTRODUCTION

Indonesia, as a developing country with rapid economic growth, faces great challenges in the construction sector, especially the growing demand for infrastructure. Concrete, as the main material, plays an important role in sustainable development, but innovation is needed to improve its efficiency, durability and sustainability. One potential innovation is the utilization of asphalt waste from road repair projects, such as the Scrapping-Filling Overlay (SFO) method. Scrapping-Filling Overlay (SFO) is a method of maintaining flexible pavement by stripping and replacing the old asphalt layer. This process produces Reclaimed Asphalt Pavement (RAP) waste, which is material from old pavements that can be reused as a partial replacement for coarse aggregate in concrete mixes. As per SNI 8198:2015, RAP is obtained through milling of old asphalt and can be recycled for road construction. Its use provides technical, economic and environmental benefits by reducing waste and providing a disposal solution for road demolition materials. Asphalt waste from road maintenance continues to increase as infrastructure grows. Its use in concrete can reduce waste while improving the quality and durability of concrete. This research analyzes the effect of asphalt waste on

concrete compressive strength as a sustainable alternative for the construction industry in Indonesia. By evaluating the benefits and challenges of its implementation, this research is expected to contribute to more environmentally friendly construction innovations.

METHODS

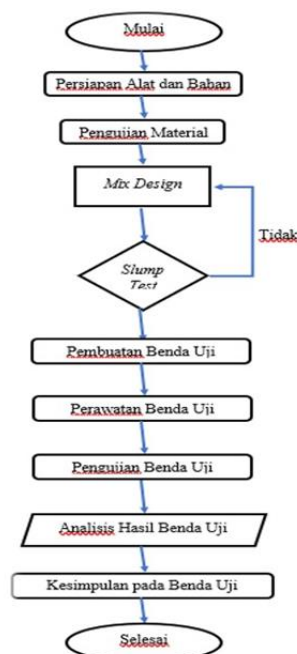
This study was conducted through an experimental approach. The objective of this study was to identify the causal relationship between the dependent and independent variables. The dependent variable was a variation of normal concrete with a concrete grade of $f'c$ 25 MPa or equivalent to K-300, while the independent variable was a concrete sample containing asphalt scrap waste as a partial replacement of coarse aggregate at 5% and 10%.

Table 1: Total number of samples

No.	Sampel Benda Uji (Kadar Limbah Aspal Scrap)	7 hari	14 hari	28 hari	Jumlah Benda Uji
1.	Uji Kuat Tekan Ukuran 15 x 30 cm, Variasi 0 %	2	2	2	6
2.	Uji Kuat Tekan Ukuran 15 x 30 cm, Variasi 5 %	2	2	2	6
3.	Uji Kuat Tekan Ukuran 15 x 30 cm, Variasi 10 %	2	2	2	6
Jumlah					18

Source: Processed Research Data, 2024.

In this study, the initial stage of preparing materials such as sand, gravel, cement, water and asphalt scrap waste. Furthermore, testing was carried out in the laboratory of PT Pionir Beton Plant Karawang, then carried out the mix design process using the Microsoft Excel software application and carried out the trial mix process, if the slump test results were according to plan, it would be continued with the process of making sample test objects which were molded using cylinders of size $\varnothing 15 \times 30$ cm. After the concrete is unloaded from the cylinder mold for 24 hours, the concrete is immediately soaked (curing) until the specified day. After the concrete is ready on the specified day, the concrete will be tested for compressive strength and get the results to be analyzed so that conclusions are obtained.



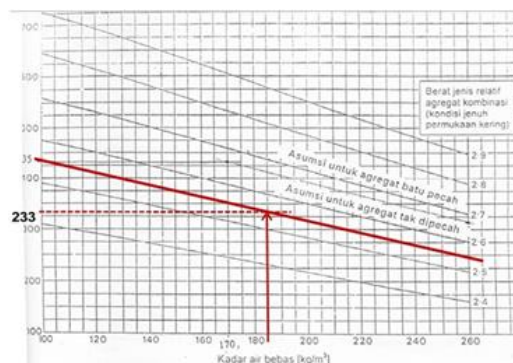
Source: Processed Research Data, 2024.

Figure 1. Research Flow Chart

RESULTS AND DISCUSSION

The tests carried out in this study include aggregate inspection such as specific gravity analysis, gradation analysis and wear testing of coarse aggregate / crushed stone using a Los Angeles machine. The concrete batching plant is designed to meet the needs of customers in the construction industry and to meet the needs of customers in the construction industry. Normal Concrete Quality Mix Design f_c' 25 (Mpa) or equivalent K-300. The provisions of the normal concrete plan, as follows:

1. Planned concrete quality = f_c' 25 (Mpa);
2. Concrete is used indoors / non-corrosive;
3. Standard Deviation = 7 Mpa;
4. Slump height set = 10 ± 2 cm;
5. Test piece (cylinder) = 15 x 30 cm in diameter;
6. Type of cement = Portland cement;
7. Maximum aggregate grain = 40 mm;
8. Specific gravity of sand (SSD) = 2.50 kg/m³;
9. Specific gravity of split (SSD) = 2.60 kg/m³;
10. Planned concrete = 33.2 MPa
 $(f_{c'r} = f_c' + (1.64 \times S) = 25 + (1.64 \times 7) = 33.2 \text{ Mpa})$
11. Free cement water factor = 0.475
12. Free water content:
 Free water content for unbroken aggregate sand 175 kg/m³
 Free water content for split aggregate 205 kg/m³
 Free water content = $(2/3 \times 175) + (1/3 \times 205) = 185 \text{ kg/m}^3$
13. Water content of cement = $185 / 0.475 = 389.5 \text{ kg/m}^3 \approx 390 \text{ kg/m}^3$
14. Aggregate combined fine aggregate percentage = $(32\% + 40\%)/2 = 36\%$
15. Coarse aggregate percentage = $100\% - 36\% = 64\%$
16. Specific gravity of combined aggregate = $(36\% \times 2.500) + (64\% \times 2.600) = 2.564$



Source: Processed Research Data, 2024.

Figure 2. FNormal Concrete Content Chart

The concrete content weight is sought using the graph above according to the specific gravity and free water content.

Concrete content weight = 2335 kg/m³

Normal concrete planning K-300

Aggregate content = $2335 - 390 - 185 = 1760 \text{ kg/m}^3$

Total fine aggregate = $36\% \times 1760 \text{ kg/m}^3 = 633.6 \text{ kg/m}^3$

Total coarse aggregate = $64\% \times 1760 \text{ kg/m}^3 = 1126.4 \text{ kg/m}^3$

Cylindrical test specimens with a diameter of 15 cm and a test specimen height of 30 cm with the number of test specimens for each variation of 6 test specimens. Then the volume of the slinder test object is:

Volume = Cross-sectional Area x height = $(1/4 \times \pi \times d^2) \times tinggi = (1/4 \times 3.14159 \times 15 \text{ cm} \times 15 \text{ cm}) \times 30 \text{ cm} = 5301.4376 \text{ cm}^3 \approx 0.0053 \text{ m}^3$.

From the calculation results, the recapitulation of concrete mix planning can be seen in Table 2 below:

Table 2 Recapitulation of Concrete Mix Planning

Keterangan	semen	air	Agregat	
	(kg)	(kg)	Halus (kg)	Kasar (kg)
Proporsi campuran Teoritis	2,07	0,98	3,36	5,97
Setiap m ³	390,0	185	633,6	1126,4
Setiap campuran Uji: 0,0159 m ³	0,0159 x 390,0 = 6,20	0,0159 x 185 = 2,94	0,0159 x 633,6 = 10,07	0,0159 x 1126,4 = 17,90

Source: Processed Research Data, 2024.

Waste Asphalt Scrap Requirement

For the use of substitute materials using asphalt scrap by 5% and 10% with a specific gravity of asphalt scrap 2.250.

Table 3 Calculation of Asphalt Scrap Needs

Variasi	Berat Jenis	Berat Split	Volume Silinder	Kebutuhan Aspal Scrap (kg)
5 %	2,25	1126,4	0.0053	0,30
10 %	2,25	1126,4	0.0053	0,60

Source: Processed Research Data, 2024.

In this study, we examined the effect of a normal concrete mix with 5% and 10% asphalt scrap waste on the slump value of normal concrete.

Table 4 Concrete Slump Test Values of Normal Concrete & Variety Concrete

Sampel	Nilai Slump	Satuan
Beton Normal	12	cm
Beton Variasi 1	12	cm
Beton Variasi 2	12	cm

Source: Processed Research Data, 2024.

Results of Concrete Compressive Strength Testing

Based on SNI 1974-2011 establishes procedures for testing the compressive strength of concrete with cylindrical test objects for testing the compressive strength of concrete. The following results of concrete compressive strength testing were carried out on test specimens aged 7 days, 14 days, and 28 days. Tests are carried out with a concrete press test tool, which uses readings on the tool with units of kN and digital displays, as shown in Table 5 through Table 7 and in Figure 3 below.

Table 5 Recapitulation of Normal Concrete Compressive Strength Test Results

No	Kode Benda Uji	Umur	Slump (cm)	Berat Benda Uji (kg)	Beban (KN)	Kuat Tekan Beton (Mpa)	Rata -rata kuat tekan beton (Mpa)
1	fc' 25	7 hari	12	12,268	286,3	16,2	16,36
2	fc' 25		13	12,27	291,8	16,51	
3	fc' 25	14 hari	13	12,3	384	21,73	21,78
4	fc' 25		13	12,294	385,8	21,83	
5	fc' 25	28 hari	13	12,312	456,3	25,82	25,57
6	fc' 25		13	12,306	447,2	25,31	

Source: Processed Research Data, 2024.

Table 6 Recapitulation of Concrete Compressive Strength Testing Results 5% Variation

No	Kode Benda Uji	Umur	Slump (cm)	Berat Benda Uji (kg)	Beban (KN)	Kuat Tekan Beton (Mpa)	Rata -rata kuat tekan beton (Mpa)
1	fc' 25	7 hari	10	12,27	306	17,32	17,11
2	fc' 25		13	12,268	298,7	16,9	
3	fc' 25	14 hari	10	12,302	391,2	22,14	22,08
4	fc' 25		13	12,298	389	22,01	
5	fc' 25	28 hari	13	12,31	440,4	24,92	24,88
6	fc' 25		13	12,318	438,7	24,83	

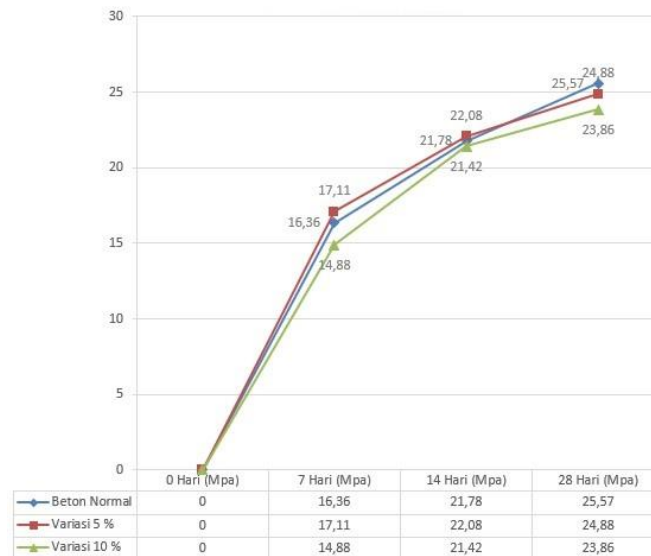
Source: Processed Research Data, 2024.

Table 7 Recapitulation of 10% Variation of Concrete Compressive Strength Testing Results

No	Kode Benda Uji	Umur	Slump (cm)	Berat Benda Uji (kg)	Beban (KN)	Kuat Tekan Beton (Mpa)	Rata -rata kuat tekan beton (Mpa)
1	fc' 25	7 hari	12	12,27	257,5	14,57	14,88
2	fc' 25		13	12,266	268,2	15,18	
3	fc' 25	14 hari	12	12,296	376,8	21,32	21,42
4	fc' 25		13	12,304	380,3	21,52	
5	fc' 25	28 hari	13	12,308	417,2	23,61	23,86
6	fc' 25		13	12,316	425,8	24,1	

Source: Processed Research Data, 2024.

In the combined graph at each test age above, it can be seen that the compressive strength of normal concrete with 5% and 10% variation concrete has increased concrete compressive strength.



Source: Processed Research Data, 2024.

Figure 3. The results of concrete compressive strength based on the age of testing

From the graph above, it is known that the compressive strength of normal concrete at the age of 7 days reaches 16.36 MPa, at the age of 14 days it reaches 21.78 MPa, and at the age of 28 days it reaches 25.57 MPa. Where it can be concluded that the compressive strength of concrete increases at the age of 7 to 28 days. From the graph above, it is known that the compressive strength of 5% asphalt variation concrete at the age of 7 days reached 17.11 MPa, at the age of 14 days reached 22.08 MPa, and at the age of 28 days reached 24.88 MPa. Where it can be concluded that the compressive strength of concrete increases at the age of 7 to 28 days. From the graph above, it is known that the compressive strength of normal concrete at the age of 7 days reaches 14.88 MPa, at the age of 14 days it reaches 21.42 MPa, and at the age of 28 days it reaches 23.86 MPa. Where it can be concluded that the compressive strength of concrete increases at the age of 7 to 28 days. In the combined graph at each test age above, it can be seen that the compressive strength of normal concrete with 5% and 10% variation concrete has increased concrete compressive strength.

CONCLUSIONS

Based on the research conducted in the laboratory of PT Pionir Beton Plant Karawang, West Java, as well as the discussion in the previous chapter on how the use of asphalt scrap waste as a substitute for coarse aggregate in concrete impacts the compressive strength of concrete, it can be concluded that:

- 1) Based on the results of the average concrete compressive strength test for normal concrete at the age of 28 days is 25.57 MPa, the compressive strength results are more than the planned concrete quality of 25 Mpa;
- 2) Based on the results of the study, it was found that concrete using asphalt scrap waste as a substitute for some coarse aggregates at the age of 28 days at a 5% variation of 24.88 MPa and a 10% variation of 23.86 MPa, it can be concluded that the greater the use of asphalt scrap waste, the compressive strength of the concrete results decreased.

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