

UTILIZATION OF RUBBER SANDALS WASTE AS PARTIAL SUBSTITUTION MATERIAL FOR COARSE AGGREGATE IN CONCRETE MIXTURE

Pandu Arifin¹, Sahat Martua Sihombing², Achmad Pahrul Rodji³

^{1,2,3}Department of Civil Engineering, Krisnadwipayana University
Email : panduarifin99@gmail.com

ABSTRACT

In Indonesia, there is an increasing demand for building materials, especially concrete which is popularly used to construct bridges, houses, buildings, and highways because it is cheap and easy to form. However, concrete has weaknesses in resisting tensile loads and the repeated use of aggregates leads to a reduction in natural resources. This study investigates the use of waste rubber sandals as an alternative to coarse gravel in concrete to reduce environmental damage and add economic value to construction projects through experimental concrete strength testing. From the data analysis and discussion in the previous chapter regarding the use of rubber sandal waste with variations of 0%, 5%, and 10%, the results of compressive strength testing on normal concrete at the age of 28 days were 440 kN (f'c 24.91 MPa), while in variation 1 rubber sandal waste 5% was 297 kN (f'c 16.82 MPa) and in variation 2 rubber sandal waste 10% was 248 kN (f'c 14.04 MPa).

Keywords: Concrete, Compressive Strength, Rubber Slippers.

INTRODUCTION

The demand for building materials in Indonesia is increasing, especially concrete used in construction such as bridges, houses, buildings, and highways because of its low price and ease of forming. However, concrete is weak against tensile loads and the repeated use of aggregates from the soil causes depletion of natural resources. This study explores the use of rubber sandal waste as a substitute for coarse gravel in concrete to reduce environmental impacts and provide economic value to construction projects, with experimental concrete strength tests.

METHODS

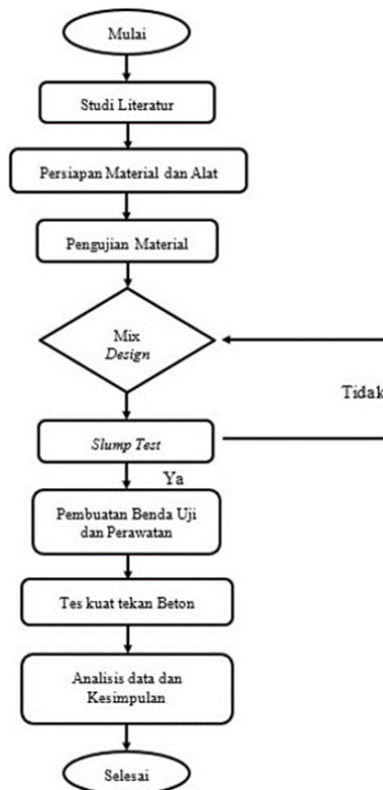


Figure 2. Research Flowchart

This study uses an experimental research design, including independent and dependent variables. Rubber sandal waste used as a partial replacement of coarse aggregate in concrete composition is the independent variable in this study. In this study, f'_c 25 MPa which is equivalent to K-300, is the dependent variable.

Table 1. Number of Cylindrical Test Objects

No	Sampel Benda Uji Silinder	Jumlah Sampel Berdasarkan Umur Pengujian			Jumlah
		7 hari	14 hari	28 hari	
1	Beton normal f'_c 25 MPa setara K-300	3	3	3	9
2	Penambahan limbah sandal ~~karst~~ sebagai pengganti sebagian agregat kasar dengan variasi 5 %	3	3	3	9
3	Penambahan limbah sandal ~~karst~~ sebagai pengganti sebagian agregat kasar dengan variasi 10 %	3	3	3	9
Total Benda Uji					27

The instruments used in this study include electronic weighing, cylindrical concrete mold, concrete mixer, concrete compression tester, Los Angeles abrasion machine, sieve analysis, rubber hammer, oven, Abram cone, slump test base plate, meter, wheelbarrow, small shovel.



Figure 3. Sieve Analysis

The concrete mix design process involves selecting and determining the proportions of materials to create concrete that has optimal strength, high durability, and is cost efficient. Challenges in designing a concrete mix include variations in material quality, lighting conditions at the job site, and the specific requirements of the project, making this a complex task. A thorough understanding of the characteristics of materials, concrete, and pavement techniques is required. Referring to the SNI 03-2834-2000 standard, the general concrete mix design for the project is projected to have a compressive strength f'_c of 25 MPa or equivalent to K-300, setting the ratio or composition of materials that are essential to achieve the desired compressive strength.

Table 2. Concrete f'_c 25 MPa For 1 Cylinder

No	Material	Volume	Satuan
1	Semen	2,412	Kg
2	Agregat Halus (Pasir)	3,592	Kg
3	Agregat Kasar (Batu Split)	5,476	Kg
4	Air	0,928	Kg

RESULTS AND DISCUSSION

This chapter will explain the data analysis that has been carried out from the results of the tests that have been carried out. The compressive strength results of ordinary concrete and concrete made with rubber sandal waste substitution will be compared in this study.

Using the Los Angeles abrasion machine, the researchers tested the aggregates through various methods, such as specific gravity measurement, gradation analysis, and coarse aggregate wear testing. Furthermore, the prepared samples underwent a compressive strength test with a compression tester and a slump test.

Table 3 Results of Coarse Aggregate Sieve Analysis Test

Saringan		Berat Tertahan (gram)	Jumlah (%)		
Nomor	Ukuran (mm)		Tertahan	Lolos	Berat Tertahan Kumulatif
1,5 in	38,10	0.0	0	100	0
1 in	25,4	1877.5	37.55	62.450	37.55
3/4 in	19,10	1205.5	24.11	38.340	61.66
0,5 in	12,50	1302.5	26.05	12.290	87.71
3/8 in	9,52	97.5	1.95	10.340	89.66
4	4,75	485.4	9.707	0.633	99.367
8	2,36	18.3	0.366	0.267	99.733
16	1,18	4.4	0.087	0.180	99.820
30	0,6	9.0	0.180	0	100.000
Pan		0.0	0	-	-
Jumlah		5000	100.000		675.500
Hasil pengujian modulus Kehalusan Agregat Kasar Sebesar $675,500 / 100 = 6,75\%$					
Spesifikasi SNI 03-1968-1990 nilai maksimum sebesar 8%					

Table 4 Results of Specific Gravity and Absorption Test of Coarse Aggregate

Pengujian Berat Jenis dan Penyerapan Air Agregat Kasar				
No	Uraian	Satuan	Rumus	Hasil Pengujian
1	Berat agregat kering mutlak (BK)	gr	-	4895,5
2	Berat agregat kasar (SSD)	gr	-	5000
3	Berat agregat kasar dalam air (BA)	gr	-	3047
4	Berat jenis curah	-	$BK / (SSD - BA)$	2,507
5	Berat jenis SSD	-	$SSD / (SSD - BA)$	2,560
6	Berat jenis semu	-	$BK / (BK - BA)$	2,648
7	Penyerapan air	%	$(SSD - BK) / BK * 100$	2,135

Table 5 Coarse Aggregate Wear Test Results

Pengujian Abrasi / Keausan Agregat Kasar Dengan Mesin Los Angeles				
No	Uraian	Satuan	Rumus	Hasil Pengujian
1	Berat agregat kasar mula mula (A)	Gr	-	10640
2	Berat agregat tertahan no.12 (B)	Gr	-	678
3	Nilai Keausan / Abrasi	%	$(A - B) / A * 100\%$	0,93

Using SNI 03-2834-2000 on "Procedures for Making Normal Concrete Mixture Plans" as a guide, this concrete mix design attempts to ensure the amount or composition of elements needed for concrete preparation. The test results will be evaluated at 7, 14, and 28 days, based on the results of the mix design for a single cylindrical test object measuring 15 cm x 30 cm.

The standard quality of the mix design for 25 MPa is comparable to K-300. Special plan provisions:

- 1) Planned concrete quality = $f'c$ 25 MPa
- 2) Cylinder test object = $\varnothing$ 15 cm x 30 cm
- 3) Standard deviation = 7 MPa

- 4) Cement type = type 1
- 5) Slump height is set = 10 ± 2 cm
- 6) Maximum FAS value = 0.6
- 7) Minimum cement content = 275 kg / m³
- 8) Sand density = 2.54
- 9) Split density = 2.56
- 10) Maximum grain size = 40 mm

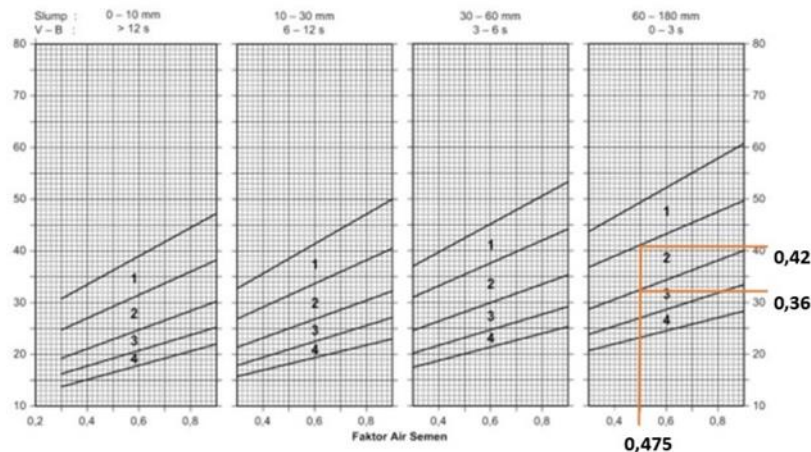


Figure 4. Graph of % Sand to Total Aggregate Content Recommended for Maximum Grain Size of 40 mm

Rubber Substitute Material

For the use of fine aggregate substitute material using rubber sandal waste of 5% and 10%. The specific gravity of rubber sandals can be seen below,

- 1) The specific gravity of rubber sandal waste needed as a substitute for fine aggregate is 5% = 5% rubber sandal waste. weight of fine aggregate. cylinder volume = 0.17 kg
- 2) The specific gravity of rubber sandal waste needed as a substitute for fine aggregate is 10% = 10% rubber sandal waste. weight of fine aggregate. cylinder volume = 0.34 kg

The concrete samples were tested for compressive strength after 7, 14, and 28 days using a compression test machine. This tool uses a digital display to show the value in kN. In addition to Table 6 to Table 8, the data on the results of the concrete compressive strength test can be seen in Figures 5 and 6 below.

Table 6 Compressive Strength Analysis Test of 7-Day-Old Cylinder Concrete Load

No	Benda Uji	Tanggal Pembuatan	Tanggal Pengujian	Umur Benda Uji (hari)	Berat Benda Uji (kg)	Aktual Kuat Tekan kN	Rata-rata Kuat Tekan kN	Rata-rata Kuat Tekan kN
1	fc'25	27 Mei 2024	3 Juni 2024	7	11,85	265		
2	fc'25	27 Mei 2024	3 Juni 2024	7	12,1	274	266	60,18%
3	fc'25	27 Mei 2024	3 Juni 2024	7	11,7	260		
1	5% SK	6 Juni 2024	13 Juni 2024	7	11,4	147		
2	5% SK	6 Juni 2024	13 Juni 2024	7	11,6	155	163	36,88%
3	5% SK	6 Juni 2024	13 Juni 2024	7	11,7	186		
1	10% SK	13 Juni 2024	20 Juni 2024	7	11,55	123		
2	10% SK	13 Juni 2024	20 Juni 2024	7	11,7	146	135	30,54%
3	10% SK	13 Juni 2024	20 Juni 2024	7	11,6	137		

Table 7 Compressive Strength Analysis Test of 14-Day-Old Cylinder Concrete Load

No	Benda Uji	Tanggal Pembuatan	Tanggal Pengujian	Umur Benda Uji (hari)	Berat Benda Uji (kg)	Aktual Kuat Tekan kN	Rata-rata Kuat Tekan kN	Rata-rata Kuat Tekan kN
1	fc'25	27 Mei 2024	10 Juni 2024	14	11,95	367	372	84,16%
2	fc'25	27 Mei 2024	10 Juni 2024	14	12,16	372		
3	fc'25	27 Mei 2024	10 Juni 2024	14	11,9	377		
1	5% SK	6 Juni 2024	20 Juni 2024	14	11,7	221	243	54,98%
2	5% SK	6 Juni 2024	20 Juni 2024	14	11,9	262		
3	5% SK	6 Juni 2024	20 Juni 2024	14	11,6	247		
1	10% SK	13 Juni 2024	27 Juni 2024	14	11,4	204	200	45,25%
2	10% SK	13 Juni 2024	27 Juni 2024	14	11,6	221		
3	10% SK	13 Juni 2024	27 Juni 2024	14	11,7	176		

Table 8 Compressive Strength Analysis Test of 28-Day-Old Cylinder Concrete Load

No	Benda Uji	Tanggal Pembuatan	Tanggal Pengujian	Umur Benda Uji (hari)	Berat Benda Uji (kg)	Aktual Kuat Tekan kN	Rata-rata Kuat Tekan kN	Rata-rata Kuat Tekan kN
1	fc'25	27 Mei 2024	24 Juni 2024	28	11,85	445	440	99,55%
2	fc'25	27 Mei 2024	24 Juni 2024	28	12,1	439		
3	fc'25	27 Mei 2024	24 Juni 2024	28	11,7	436		
1	5% SK	6 Juni 2024	4 Juli 2024	28	11,6	267	297	67,19%
2	5% SK	6 Juni 2024	4 Juli 2024	28	11,8	303		
3	5% SK	6 Juni 2024	4 Juli 2024	28	11,7	321		
1	10% SK	13 Juni 2024	13 Juli 2024	28	11,4	227	248	56,11%
2	10% SK	13 Juni 2024	13 Juli 2024	28	11,6	277		
3	10% SK	13 Juni 2024	13 Juli 2024	28	11,5	239		

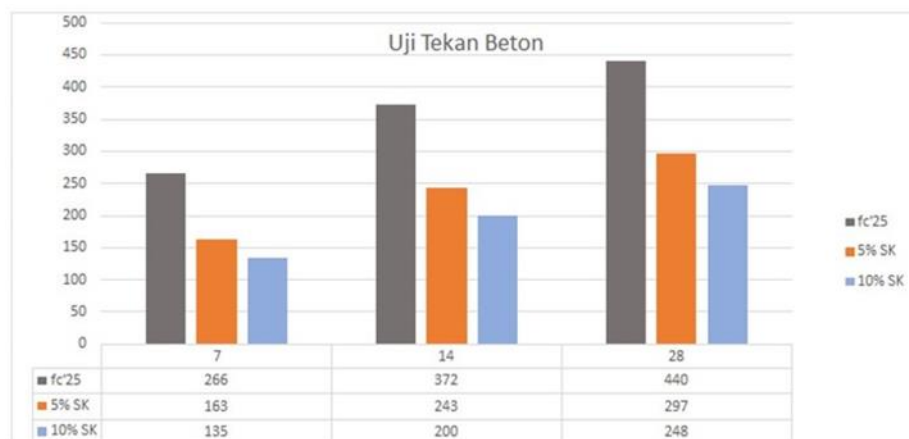


Figure 5. Normal Concrete Compression Test Bar Diagram, Variation 1 and Variation 2

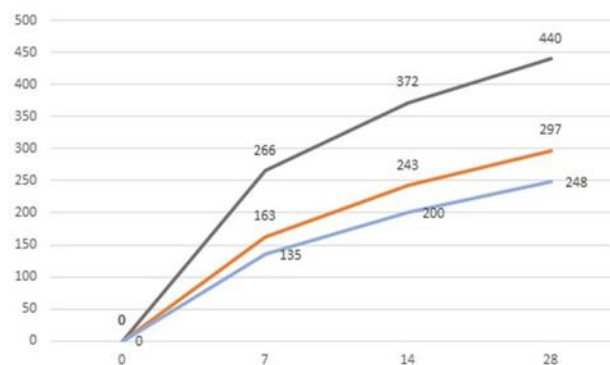


Figure 6. Normal Concrete Compression Test Graph, Variation 1 and Variation 2

CONCLUSIONS

From the data analysis and discussion in the previous chapter regarding the use of rubber sandal waste with variations of 0%, 5%, and 10%, the results of the compressive strength test on normal concrete at the age of 28 days were 440 kN (f'c 24.91 MPa), while in variation 1, 5% rubber sandal waste was 297 kN (f'c 16.82 MPa) and in variation 2, 10% rubber sandal waste was 248 kN (f'c 14.04 MPa).

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