Compressive Test of Concrete With Teak Wood Attached Waste Iron Lathe as a Replacement of Coarse Aggregate

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Research Article

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Abstract

The research team thought about the sustainability of concrete material because the stone used every year will be exhausted for the next generation. Innovation material renewable, sustainable, and waste materials required. This is pre-research teak wood used as a mixture to reduce coarse aggregate stone, added containing lathe waste to give friction to the wood. Objective: find an alternative coarse aggregate, with renewable and sustainable materials. Experimental methods in laboratories with relatively high quality are widely used in construction projects in Indonesia.

Standard quality plan of concrete fc29.05 MPa, variation t 1 coarse aggregate teak wood 10%, variation t 2 teak 9.5%, lathe waste 5%. Test results of standard concrete 28.87 MPa, 13.70 MPa Variation 1 drop 52.75.. % and 14.24 MPa variation 2 drops 49.18 % The failure of standard concrete experienced large cracks, while variations 1 and 2 were smaller, which means it is not brittle and light, which is advantageous in applying the concrete structure for buildings. The conclusion. alternative use of teak wood waste material, especially attached iron lathe filler waste, is very useful for the sustainability of the use of concrete. However, mixed concrete design requires a higher concrete quality to achieve applied concrete

1. Introduction

The research team is looking for alternative concrete materials using residual and sustainable and renewable materials. Wood is a sustainable and renewable material. in 2020, Indonesia's natural forest area was 125.2 million hectares, which consisted of conservation forests 27.3 million hectares (21.80%), protected forests 29.5 million hectares (23.56%), and production forests 68.6 million hectares or 54.79%. An area of 29.1 million hectares of permanent production forest, 26.7 million hectares of limited production forest, and 12.8 million hectares of production forest can be converted for development needs (Sugiarto, 2021)

Indonesia's natural forest area is 125.2 million hectares, consisting of 27.3 million hectares (21.80%) of conservation forest, 29.5 million hectares of protection forest (23.56%), and 68.6 million hectares of production forest, or 54.79%. An area of 29.1 million hectares of permanent production forest, 26.7 million hectares of limited production forest, and 12.8 million hectares of production forest can be converted for development needs. Since 1979-2018, covering an area of 563,463 hectares, village forests covering an area of 1,551,601 hectares, community forests covering an area of 743,406.82 hectares, and forestry partnerships covering an area of 424,940 hectares are still combined with the use of production forests so that the protected forest data used are still not real because they have not been separated. from production forests. In community forests whose wood products are also expected to replace (substitute) the lack of wood products from natural forests, the potential of community forests in Indonesia reaches 34.8 million with a composition and an area of 2.7 million ha in Java with a potential of 78.7 million m3, while outside Java, the area is 32.1 million ha with a potential of 912 million m3. Community forests supply 46.9% of the national need for logs. The types of wood that are planted, especially in Java, are sengon, mahogany, teak, jabon, rosewood, and so on. The use of wood as a construction material and furniture has long been used in Indonesia, but sometimes deforestation occurs, and sometimes it has not been reforested. If the people and the Indonesian government realize the need for sustainable and renewable materials. There is no unused land and no deforestation. This research is the beginning of continuous research on waste wood and waste materials for concrete so that concrete materials in Indonesia are sustainable and available for generations to come. The use of iron shaved material is not environmentally friendly, or waste material from iron or steel can be an alternative to using concrete; even the use of liquid steel to replace or reduce cement has been used to achieve high-quality concrete. What needs to be remembered is that the Fe material is not renewable and sustainable, but it can be recycled. Iron ore is scattered almost all over the Earth's surface in the form of iron oxide. Although the Earth's core is composed of iron and nickel, the iron oxides on the Earth's surface do not come from it but from meteors that fall on Earth. Islands of Java, Kalimantan, Sumatra, Sulawesi, and Irian Jaya with a total exceeding 1,300 million tons, even though the iron content is still low between 35-58 percent Fe (page 9)

The use of stone for construction every year in Indonesia is not necessarily available, and it is necessary to find a new location for the quarry. While the availability of stone is limited because the stone does not grow and cannot be renewable, it can only be recycled; of course, the quality is relatively low. The concrete material used was teak wood residue chopped irregularly between 30-40 mm.

Concrete is used because it has high compressive strength characteristics for construction structures to obtain the compressive strength according to the target. This research using pieces of teak wood and iron shavings has not been achieved, but the authors publish so that the research team gets input from readers for the research team to continue research. This research team is comparing the weight composition of stone aggregate and teak wood aggregate. In addition, the research team had difficulty obtaining OPC cement because it was not sold in small volumes, and there are very large volumes for the concrete industry, so using PCC cement in standard concrete quality is difficult to achieve. A mixture of the coarse aggregate reduces the use of stone. Utilizing this waste is produced by a factory or workshop of iron shavings, which is a waste of iron lathe waste that is difficult to decompose and is still rarely used.

The research team did not receive research funding from any sources, and the research team was from the developing county, so the samples made were limited according to the available costs of the research team.

2. Theoretical Background

Concrete is a mixture of cement, water, and aggregate. Sometimes it is added using added ingredients in a certain ratio, ranging from additional chemicals and fillers to nonchemical waste materials.

Concrete Material

Mixed materials: with a mixed design calculation, namely:

1. Standard concrete fc 29.05 MPa with cement, coarse aggregate (crushed stone, fine aggregate (sand), and water.
2. Variation 1: Cement, coarse aggregate (crushed stone with 10% teak waste by weight of crushed stone), fine aggregate (sand), and water
3. Variation 2: Cement, coarse aggregate (crushed stone with teak wood waste 9.5% by weight with shaved waste 0.5% from the crushed stone weight), fine aggregate (sand), and water

Good cement for concrete quality should be OPC but it nothing be in the form of zak kg, buy in bulk because it damages the environment

Coarse Aggregate

Must not contain more than 1% sludge, retained by filter No. 4. (gradation of aggregate grains based on the standard SK SNI T–15–1990–032 (p. 2) with... Coarse aggregate must not contain more than 1% mud. The coarse aggregate used is crushed stone with a size of 30 mm or 30 mm – 40 mm. In concrete mixtures, aggregate is a strengthening and filler material and occupies 60%-75% of the total volume of concrete.

Fine aggregates should not contain more than 5% silt and should not contain too much organic matter. Pass filter No. 4.

The water used for the concrete mixture is water that meets the requirements and must be clean and does not contain organic substances, oils, acids, alkalis, or other materials that can damage the concrete.

Teak wood

The characteristics of teak wood are its durability and resistance to weather changes compared to other woods. This wood has an average MC level of 12% and has a strong resistance to mold and rot due to humid air or insect attack. Teak wood also has good resistance to weather and temperature changes. Teak wood waste from the rest of the building frames and furniture is shaped 30-40 mm

Waste Iron Lathe

Lathe waste is a waste item consisting of similar or nonexistent iron components, which are decomposed from their original form

Factories or workshops produce a large amount of scrap iron. This type of good is usually made from shavings of material such as iron pipes, rods, stale plates, and various other forms of manufacturing residue. Lathe iron waste is a business engaged in the automotive sector, and lathe workshops produce iron waste from repaired machines. This waste is the result of scraping and shaving of repaired machines, producing fine metal or iron flakes. Garbage is just thrown away, and it is still rare to use. The waste iron lathe is pasted on teak wood for rough aggregate. Lathe waste is a waste item consisting of similar or not iron components, which decomposes from its original form, and its function is not the same as the original. Factories or workshops produce a large amount of scrap iron. This type of good is usually made from scraps of material such as iron pipes, rods, stale plates, and various other forms of manufacturing leftovers.

The density of teak wood ranges from 0.62 to 0.75, while the modulus of elasticity under dry conditions is approximately ± 12523 MPa (Martawijaya 1981:42).

The best value of specific gravity and static bending strength of teak in this study is teak wood at the tip near the bark, where the average density value in wet conditions is 0.644, specific gravity in air-dry conditions is 0.699, and specific gravity in dry furnace conditions is 0.699. 0.714 (Agustin D.A. , Ngadianto. A, S. (2015)

Fauzi M. F, Nursyamsi (2014) The results showed that there was a decrease in the density of concrete with the addition of 2.5% sawdust content: 5%, 7.5%, and 10%. Decrease in content weight by 0.47%; 1.42%; 2.39%; 3.88% of the standard concrete fc 29.05 MPa so that the concrete made using sawdust becomes lighter than the standard concrete fc of 29.05 MPa.

Wichrowska K. K,†, Pawluczuk E, Bołtryk Mi, imenez J. R., Rodriguez J. M. F., Morales D. S (2022) The Performance of Concrete Made with Secondary Products—Recycled Coarse Aggregates, Recycled Cement Mortar, and Fly Ash–Slag Mix

Ervianto, M., Saleh, F., Prayuda, H. (2016. High-strength concrete cannot always be achieved only by using conventional materials without the addition of special additives. High-strength concrete requires the use of cement, which is more than the use of cement in normal concrete, so it is necessary to add fly ash to the high-strength concrete mixture to reduce the use of cement, although it is not too significant. The addition of additives (best Mittel) in high-strength concrete made from fly ash affects the compressive strength of the concrete. The greater the fly ash used, the greater the value of the compressive strength, but the compressive strength will decrease if too much fly ash is used. The results of the compressive strength of concrete with the addition of fly ash and additives (Betsmittel) were 5%, 7.5%, and 10% of 35.95 MPa; 41.49 MPa; and 40.45 MPa. (abstract)

HPC and UHPC production. As a material with high mechanical strength, good workability parameters, and high durability. HPC and UHPC have generally used the same construction materials as conventional concrete. The type of OPC (Ordinary Pozolan Cement), which is richer in clinker and has fewer mineral additions, is required so that pozzolans with superior quality and reactivity than those used in the production of OPC are used in the production of HPC and UHPC. It is better to use OPC, which is rich in C_3S and C_2S, i.e., with low levels of Al_2O_3 and Fe_2O_3 oxides. For mineral additives, the most widely used are pozzolanic additives, such as fly ash and silica fume. Marvila, de Azevedo, A.R.G. ; de Matos, P.R. ; Monteiro, S.N. ; Vieira, C.M.F. (2021), Concrete made with FAS (fly ash slag), RCM (recycled cement mortar), and RCA (recycled aggregates) has a higher compressive strength (approximately 7%) compared to traditionally produced concrete in this case, where 30% of natural aggregate is replaced by recycled aggregate, with the additional use of the innovative FAS–RCM additive as 30% of the cement mass. (Wichrowska K. K , Pawluczuk E, Bołtryk M, Jimenez J. R, Jose Maria Rodriguez J.M. F.Morales D. S 2022)

The application of ceramic aggregates as a substitute for natural sand has a positive value with higher compressive strength, flexural strength, and tensile strength. The workability and setting time properties of alkali-activated mortar are increased with improved WCP (waste ceramic powder) content (Luhar, I.; Luhar, S.; Abdullah, M.M.A.B. ; Nabiałek, M.; Sandu, A.V. ; Szmidla, J.; Jurczy ́nska, A.; Razak, R.A. ; Aziz, I.H. A; Jamil, N.H. ; et al. (2021) Conclusions (24,25 pp 1-30)

Lightweight concrete increases with the ratio of moments caused by permanent and total loads. However, reducing the stiffness of the element requires consideration of the deflection limit

Lightweight concrete is less efficient than standard concrete, with a decrease in the ratio of permanent to total moments and an increase in the percentage of reinforcement Low. Bacinskas D., Rumsys D., Kaklauska G. (2022)m Conclusions (24,25 PP 1-30)

Steel fibers give concrete strength but cost more, so instead of steel fiber using rice straw and cement bag pieces and obtain enough strength 28 days 35.80 MPa M25 (25 MPa) is finished, while M15 is 23.6 MPa (15 MPa) and over-target power. so it can be an economical mixed design M 30 (Shah J. H, Shah S, B. 2014)

According to SNI 03-6827-2002, concrete setting time is a gradual process, so each definition of concrete setting time must be treated irregularly. The initial setting time will be determined from the penetration time graph, i.e., where the penetration of the Vicat needle reaches a value of 25 mm. This research did not test the setting time of concrete but on SNI 12.2 Method of Testing Concrete Bonding Time with Penetration Resistance. The average initial setting time varied from 169 to 252 minutes. The average final setting time ranges from 240 to 341 minutes. Three replication determinations were performed by each operator on the test samples prepared from one container of each mixture. Test Method for SNI Concrete Bonding Time with Penetration Resistance ASTM C403. C403 M=08, IDT) According to SNI 03-6827-2002

Experimental Investigation Material

The research was carried out in 5 things, namely:

1. The number of test objects is 3 pieces for each age, namely, 7 days, 21 days, 28 days for standard concrete fc 29.05 MPa, with a mixture of teak wood waste and iron lathe, 10% teak and 9.5% teak wood with 0.5% lathe iron waste, so the total number of test objects is 27 pieces.

2. The test object is a cylinder with a diameter of 15 cm and a height of 30 cm. Standard concrete with the other 2 variations ts is subjected to pressure test immersion.
3. Use of iron lathe attached to teak wood as a friction
4. Black sand with a specific gravity of SSD 2.49 was used and split with a density of SSD 2.48 from teak SSD density of 0.67. Specific gravity test results in the laboratory. Water-saturated density (SSD)0.644 test results Agustin D. A, Ngadianto A,)
5. The material used was Portland cement type 1, non-OPC

3. Material Test Result

The research team takes the following steps:

See Figure 1. Concrete (Standard, Variations 1 and 2) Research Diagram

The material test consists of

a. Fine aggregate gradation, specify gravity
b. Coarse aggregate gradation, specify gravity
c. Fine Aggregate Gradation Test Results On the aggregate gradation test, get the results below

Table 1 Fine Agregate Gradation Test Results

Passing Sieve (mm)	Retained Weight (gr)	Quantity Retained(gr)	Retained (%)	Pass (%)	Cumulative retained
No.4	3,1	3,1	0,62	99,38	0,62
No.8	110,2	113,3	22,04	77,34	22,66
No.16	112	225,3	22,40	54,94	45,06
No.30	80,2	313,3	16,04	38,9	61,1
No.50	88	401,3	14,00	21,9	78,7
No.100	64,9	466,2	12,98	8,32	91,68
No.200	33,4	499,6	6,68	1,64	98,36
Pan	8,2	500	1,64		100
Sum	500		100		498,18
Fine Modulus					4,9818

Based on the table above, it can be seen that sieve No. 4 has the highest pass percentage with a value of 99.38%, while sieve No. 200 has the lowest pass percentage with a value of 1.64% and a fineness modulus of 4.9818.

Figure 2 shows that the fine aggregate has a good gradation so that the s curve does not cross the lower or upper limits according to SNI 03 – 2834 -2000.

b. Coarse Aggregate Gradation Test Results

Table 2 Test Result Coarse Agregate Gradation

Passing sieve (mm)		Retined weight(gr)	Quantity detained (gr)	Retained(%)	Pass (%)	Commulatieef Retained
25.50 1 ½”		1351	1351	27,02	72,98	27,02
19,10 mm	¾”	1160,1	2511,10	23,20	49,77	50,22
12,50 mm	½”	1385,9	3897	27,71	22,06	77,94
9,52 mm	3/8”	524,5	4421,50	10,49	11.57	88,43
4,75 mm	No.4	541,7	4963,20	110,83	0,736	99,26
Pan		153	5000		0	100
Sum		5000		100	100	422,9
Fine Agregate						4,428

Based on the table, it can be seen that the 25.50 sieve has the highest pass percentage with a value of 72.98%, while the 4.75 sieve has the lowest pass percentage with a 0.736% value and a fineness modulus of 4.428.

From Figure 3, it can be seen that the gradation of fine aggregate has a good gradation so that it forms an s curve and does not cross the lower or upper limits according to SNI 03 – 2834 -2000

Formed randomly, up to approximately 30 mm or 4 mm, no gradation of teak wood aggregates

Specify Gravity Test of Coarse Aggregate and Fine Aggregate

Concrete design: standard fc 29.05 mpa, variation 1,2

Standard concrete, 29.05 mpa

Cement Water Factor. and Concrete Fill Weight

Standard concrete fc 29.05 mpa

In concrete planning, it can be done using the method according to SNI 03 – 2834 -2000 1. Standard concrete quality plan (f'c 29.05 MPa

2. Noncorrosive concrete/ in the laboratory

3. Slump plan = 60 -180 mm

4. Concrete is planned at 38,234 MPa.

f'cr = f'c + 1,64. S = 29,05 + 1,64 x 5,6 = 38,234 MPa

a. Free water content

- Free moisture content for unbroken sand aggregate 225 kg/m3
- Free moisture content for crushed rock aggregate 205 kg/m3
- Sand: 2/3 = 150 ltr
- Split stone: 1/3 = 68.3 ltr
- Total = 218, 33 ltr FAS (cement water factor) = 0.48
- Cement: 218,333 / 0.48 = 455 kg

b. Combined Aggregate

- The specific gravity (SSD) of sand = 2.48
- The specific gravity (SSD) of the split stone = 2.49
- Sand: 36% x 2.48 = 0.893
- Split stone: 64% x 2.49 = 1.594 Sum=2.49

The density of the concrete is searched using the graph above according to the specific gravity and free water content

Weight of concrete = 2250 kg/m3

Weight of concrete = 2250 kg/m3

Combined aggregate content = Weight of concrete minus the amount of cement and moisture content = 2250 - 455 - 218.33 = 1577 kg/m3

Total Fine aggregate = 36% x 1577 = 567.65 kg/m3

Total coarse aggregate = 64% x 1577 = 1009 kg/m3

Table 3 Standard Concrete Design fc 29.05 mpa

Material	Weight (kg)	Volume Cylinder(m^3)	1 cylinder (kg)	3 cyilnders (kg)	9 cylilnders (kg)
Cement	455	0,0053	2,41	7,23	21,69
Fine Agregate	567,65	0,0053	3,01	9,02	27,07
Coarse Agregate	1009	0,0053	5,35	16,04	48,13
Water	218,33	0,0053	1,16	7,23	10,41
Total			11,92	35,77	109,68

The density of concrete is searched using a graph according to SNI 03 – 2834 -2000.

Design Concrete Quality = K 350 or equivalent to 29 MPa (f'c 29.05)

Concrete for indoor use/noncorrosive

Cement used Portland cement type 1

Planned concrete 38,234 MPa

Free water content

Free moisture content for unbroken sand aggregate 225 kg/m3

Free moisture content for crushed rock aggregate 205 kg/m3

Sand: 225 kg x 2/3 = 150 ltr

Split stone: 205 kg x 1/3 = 68.3 ltr

= 218.33 ltr

FAS = 0.48

Cement: 218,333 / 0.48 = 455 kg

Combined Aggregate

Variation 1 concrete : 10 & Teak wood waste

The specific gravity (SSD) of sand = 2.48

The specific gravity (SSD) of the split stone = 2.49

Density (SSD) Teak = 0.67

Sand: 36% x 2.48 = 0.893

Split stone: 57.60% x 2.49 = 1.434

Teak wood: 6.40% x 0.67 = 0.043

Sum= 2.37

The density of the concrete is searched using the graph above according to the specific gravity and free water content.

Weight of concrete = 2175 kg/m3

Weight of concrete = 2175 kg/m3

Combined aggregate content = Weight of concrete minus the amount of cement and moisture content = 2175 - 455 - 218.33 = 1502 kg/m3

Total Fine Aggregate = 36% x 1502 = 567.65 kg/m3

Total coarse aggregate = 64% x 1502 = 961 kg/m3

Split 90% x 961 = 865 kg/m3

Teak 10% x 961 = 96.12 kg/m

Table. 4 Variation 1 design concrete

Material	Weight (kg)	Volume (Cyilinder(m³)	1 cyilinder(kg)	3cylilnders (kg)	9cylinders (kg)
Cement	455	0,0053	2,41	7,23	21,69
Sand	540,7	0,0053	3,01	9,02	27,07
Split stone	865	0,0053	4,58	13,75	41,25
Teak wood agregate	96	0,0053	0,51	1,53	4,58
Water	218,33	0,0053	1,16	7,23	10,41
Total			11,92	35,77	109,68

Source: Author

Variation 2 Concrete: Teak Wood 9,5% and Iron Lathe Concrete 0,5%

The density of concrete is searched using a graph according to SNI 03 – 2834 -2000.

Design Concrete Quality =(f'c 29.05

Concrete for indoor use/noncorrosive

Teak density (SSD) = 0.67

Iron Specific Gravity (SSD) = 7.87

Planned concrete 38,234 MPa

Free water content

Free moisture content for unbroken sand aggregate 225 kg/m3

Free moisture content for crushed rock aggregate 205 kg/m3

Sand: 225 kg x 2/3 = 150 ltr

Split stone: 205 kg x 1/3 = 68.3 ltr

= 218.33 ltr

Cement Water Factor = 0.48

Cement: 218,333 / 0.48 = 455 kg

Combined Aggregate

Density (SSD) Sand = 2.48

Specific gravity (SSD) of split stones = 2.49

Density (SSD) Teak = 0.67

Specific gravity (SSD) of Lathe Iron = 7.87

Sand: 36% x 2.48 = 0.893

Coarse aggregate: 57.60% x 2.49 = 1.43

Teak wood waste: 6.08% x 0.67 = 0.041

Waste iron lathe: 0.32% x 7.87 = 0.025. Sum = 2.39

The density of the concrete is searched using the graph above according to the specific gravity and free water content

Weight of concrete = 2190 kg/m3

c. 2 Variation concrete design

Weight of concrete = 2190 kg/m3

Combined aggregate content = Weight of concrete minus the amount of cement and moisture content = 2190 - 455 - 218.33 = 1517 kg/m3

Total Fine Aggregate = 36% x 1517 = 546.05 kg/m3

Total coarse aggregate = 64% x 1517 = 971 kg/m3

Split 90% x 971 = 863.68 kg/m3

Teak 9.5% x 971 = 96.12 kg/m3

Waste Iron lathe 0.5% x 971= 4.85 kg/m3

Table 5. Result of Concrete Design Variations 2 fc 29.05 mpa

Material	Weight (kg)	Cylinder Vol(m^3)	1Cylinder (kg/m^3)	3 Cylinders (kg)	9 Cylinders (kg)
Cement	455	0,0053	2,41	7,23	21,69
Sand	540,7	0,0053	2,89	8,68	26,04
Coarse agregate	865	0,0053	4,58	13,75	41,25
Teak wood	96	0,0053	0,49	1,53	4,58
Iron waste lathe	5	0,0053	0,03	0,08	0,23
water	218,33	0,0053	1,16	7,23	10,41
Total			11,92	35,77	109,68

Source: Author. Formation of teak wood and iron waste lathe

Slump Test

The slump test is a concrete test to determine how lumpy the concrete mix will be to achieve good quality strength, which refers to SNI 2493-3011. The slump test in this study was conducted once. The slump test results can be seen in the table below:

Table 6 Slump Test

No	Mutu	Nilai *Slump* (cm)
1	FC 29.05 MPA standard concrete	10
2	Variation 1 1 teak Vwood waste 10%	8
3	Variation 2 teak wood waste 9.5% +0.5% waste iron lathe	8

Source: Author

Based on the table above, the slump test value meets the requirements, namely, 6 cm to 16 cm according to SNI 03 – 2834 -2000. The process of implementing the slump test can be seen in the image below:

See Figures 10-12.

Table 7: Weight of a standard concrete test object. Variation 1, variation 2 age 28 days as follows:

Table 7. Weight of Concrete Test

	standard	var 1	var 2	var 1 drop %	var 2 drop %
28 days	12.1	10.8	10.92	89.25619835	90.24793388
28 days	12.06	10.86	11.1	90.04975124	92.039801
28 days	12.38	10.85	11.08	87.64135703	89.49919225
				mean	mean
				88.98243554	90.59564237

From table 7. This shows that the test object variation 1 is 11% lighter, while variation 2 is 9.5% lighter. This is advantageous for structures, especially buildings

A simple tool used in the laboratory and 27 samples of the test specimen cylinder

The tools used in this research are simple according to concrete research standards.. Standard concrete material fc 29.05 MPa, variation 1t 1: 10% teak and variation 1t 2: 9.5% teak with 0.5% waste iron lathe

4. Laboratory Results

Concrete compressive strength test results

The concrete compressive strength test was carried out on the specimens with a planned Fas (water-cement factor) of 0.48 at the ages of 7 days, 21 days, and 28 days. The full results can be seen in the table below:

Table 8. Data Recapitulation Results

Quality	Concrete age (days)	Weight (kg)	Mean weight (kg)	Max loads (kN)	Compression test (Mpa)	Mean compression test (Mpa)
Standard consrete fc 29.05 mpa	7	11,10	12,00	305	17,26	18,90
	7	12,00		376	21,28	
	7	11,80		321	18,16	
	21	12,06		420	23,76	23,33
	21	12,10		457	25,86	
	21	12,40		360	20,37	
	28	12,10		523	29,59	28,87
	28	12,38		520	29,42	
	28	12,06		488	27,61	
Variation 1 concrete	7	10,94	10,79	155	8,77	8,9
	7	10,50		151	8,54	
	7	10,76		166	9,39	
	21	10,48		178	10,07	11,01
	21	10,92		204	11,54	
	21	11,00		202	11,43	
	28	10,80		257	14,54	13,70
	28	10,86		232	13,12	
	28	10,85		238	13,46	
Variation 2 concrete	7	11,00	11,00	186	10,52	9,99
	7	10,98		195	11,03	
	7	10,78		149	8,43	
	21	10,98		206	11,65	11,72
	21	11,06		229	12,95	
	21	11,10		187	10,58	
	28	10,94		258	14,60	14,24
	28	11,10		242	13,69	

Quality	Concrete age (days)	Weight (kg)	Mean weight (kg)	Max loads (kN)	Compression test (Mpa)	Mean compression test (Mpa)
	28	11,08		255	14,43	

From the standard concrete compression test fc 29.05 MPa for 28 days, which shows that 2 cylinders exceed the quality of concrete fc by 29.05 MPa, but there is 1 cylinder, which is of low quality 27.65 MPa, a decrease of 95.25% from the highest, against the cylinder compression test 93.44% from a minimum of 29.05 MPa

Concrete variation t 1 with 10% teak coarse aggregate showed a decrease from the target of 29.05 MPa, and from 3 cylinders, the highest was 14.54 MPa, and the lowest was 13.12 MPa, an 80% decrease from the highest variation of 1 concrete.

Concrete variation 2 with 9.5% teak wood coarse aggregate with 0.5% iron lathe glued together. The highest compressive strength of 14.60 MPa. The lowest compressive strength is 13.69 MPa 93.77% decrease. Concrete with variations 1 and 2 with a difference of 3 cylinders may occur less than perfectly during the research, either by immersion, compaction, or uneven distribution of aggregate to 3 cylinders.

Figure 13, 14, 15 Visual test of standard concrete, variation 1, variation 2

Figure 16. The graph above clearly shows that there is a decrease in the compressive strength of variation 1 compared to standard concrete fc of 29.05 MPa based on the data obtained from the research results. The compressive strength of concrete 28 days for normal specimens obtains an average of 28.87 MPa, concrete variation 1 obtains an average of 13.70 MPa, while concrete variation 2 obtains 14.24 MPa.

5. Field Testing And Results

From the results of the collapse of the concrete compressive test,

a. Standard concrete fc 29.05 mpa 28 days

Of the 3 cylinders that have been tested for compressive strength, the largest cracks are found in concrete with a compressive strength of 28.87 MPa of 2 cm, while the other 2 cylinders average 1 cm.

b. Concrete with teak 10% for 28 days

Of the 3 cylinders that have been tested for compressive strength, the largest cracks are found in concrete with a compressive strength of 13.12 MPa of 1 cm, while the other 2 cylinders average 6 mm.

c. Concrete with 9.5% teak wood and 0.5% iron lathe waste 28 days

Of the 3 cylinders that have been tested for compressive strength, the largest cracks are found in concrete with a compressive strength of 13.69 MPa of 9 mm, while the other 2 cylinders average 6 mm.

There are several possibilities: there is a large decrease in standard concrete fc of 29.05 MPa: concrete with teak and concrete with teak and iron shaved waste, namely,

1. Cement did not use OPC, so the standard concrete decreases by 3% should be 29.05 MPa

2. The teak wood used is less saturated with water, as evidenced by the slump value, which is 20% lower than that of standard concrete.

3. The shape of the teak wood as a coarse aggregate does not necessarily resemble the shape of a large stone.

4. Teak wood glued with lathe waste may not stick perfectly

5. The distribution of the test specimens into cylinders may not be evenly distributed in the distribution of coarse aggregate of stone, as evidenced by standard concrete that there is one test object that drops as well as the coarse aggregate of teak wood, so small friction

6. The compaction of the test object is not perfect as well as the curing and immersion

7. Test objects need to be reproduced and need research assistance

8. Immersion of less perfect all concrete

The photos analysis of the collapse shows that the concrete with a mixture of teak aggregate is not brittle, while the concrete with coarse aggregate is brittle. This is advantageous when used for concrete structures whose collapse is not brittle because concrete is clayey so that the rock does not fall off on people or objects. The results of the compressive test of aggregate mixed with teak wood are still lower than the target fc = 29.05 MPa. This needs to be designed with a higher mix of design

Figure 17-25. Test of Standard concrete, variation of 1,2 at 7 days, 21 days, 28 days age

Teak wood 9.5% +0.5% iron lathe waste, coarse agregate. Variation 2

The colapse of each concrete standard test, variations 1 and 2

6. Conclusion

From the research results, the following conclusions can be made:

1. The compressive strength of standard concrete fc 29.05 MPa on average for 28 days is 28.87 MPa, the compressive strength of concrete with a 10% wood mixture averaged 28 days was 13.70 MPa, the compressive strength of concrete with a mixture of 9.5% wood and iron lathe is 0, 5% average 28 days of 14.24 MPa.

2. There is a decrease in the compressive strength of teak concrete by 10% by 52.75% and the compressive strength of teak wood by 9.5% with iron lathe waste 0.5% 49.18% from the standard concrete fc 29.05 MPa studied.

3. For the failure of the compressive test every 3 cylinders, the largest average failure is obtained with the smallest compressive strength. Standard concrete fc 29.05 MPa 28 days 27.61 MPa, concrete with 10% wood for 28 days 13.12 MPa, concrete with wood 9.5% and iron lathe 0.5% 28 days 13.69 MPa, and cracked concrete with mixed wood and lathe waste is 50% smaller than standard concrete fc of 29.05 MPa.

4. The advantage of using a mixture of wood coarse aggregate and lathe waste is that it is lighter, utilizes waste, and teak wood uses renewable and sustainable materials, in addition to furniture and building waste.

To overcome the non-achievement of variation 1 and variation 2, the following are carried out:

1. Cutting teak wood with a teak wood cutting machine, the results of the cuts fill each other's cavities, so they fill each other.

2. Overcome pieces of teak wood aggregate with small friction, attached to the lathe waste

3. Mix designs with higher quality, for example fc or fc = 41.50 mp or more. example fc=60.1 MPa for reach variance 2 concrete fc 29.05 MPa

4. The implementation process must be careful so that the coarse aggregate is evenly distributed in quantity on the test object, with good compaction, curing, proper immersion, quality testing machine, and quality concrete mix machine.

Declarations

Availability of data and material

All data and research results are merged in the main manuscript.

Competing interests

Competing interests did not occur, all happy (hopes to get research funding so that research can continue and can be applied in the material construction). any construction)Researchers will feel successful if research results can be used in construction work anywhere so that the use of concrete with renewable, sustainable materials and waste materials will be used all world construction

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Author 1 NST: USD $ 275,86

Author 2 MRS: USD $ 206,90

Author 3 iS: USD $ 210,87

Authors' contributions

NST wrote the concept of sustainable, renewable, and residual material concrete with teak wood material and for friction with the idea of iron waste material from the lathe. and collected some little teak wood residual Plan the composition of the remaining material, concrete quality, mix design, Check analysis and calculations for the implementation of the mix design, make a mix implementation plan so that the results are maximum. Checking the results of the specific gravity test, the results of the mix design calculation, checking all data, plot drawings, and implementation results including the mix design test, checking the research cost plan and checking the cost of realizing research results, making the main substance of the manuscript

MRS. The residual material was collected from the lathe, some of the residual teak wood was collected, the weight of each material was determined, and the density of the material was calculated with the assistance of a laboratory assistant. Carry out the implementation of mix designs from mixing pour and mold on cylinders assisted by laboratory assistants. Record and collect all data and plot drawings and document

IS calculates the composition of the mix design, checks data, graphic plot, documentation, enters data, documentation, calculates research cost plans and makes actual research costs, checks completeness of manuscript requirements

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MRS is an undergraduate degree; since 2018, it has been a professional engineer in the construction industry.

IS has been a postgraduate degree lecturer and researcher since 1996. Researchers are construction management at sciences publication science

COMPETING INTEREST

The author tries to apply simple engineering and construction, simple engineerings mechanic calculations but it is very necessary for zero accidents, zero cracks, and no deformation. The author tries to provide a simple solution but is indispensable in the construction world

Competing interests: The authors declare no competing interests.

We provide a competing interest statement in a construction method that results in time, zero accident, quality, efficient cost, and minimal risk in all construction worldwide.

References

Badan Standarisasi Nasional, (2000), Standart Nasional Indonesia nomor 03- 2834-2000 tentang Tata Cara Pembuatan Rencana Campuran Baton Normal. Jakarta: Republik Indonesia. *National Standardization Agency, (2000), Indonesian National Standard number 03-2834-2000 concerning Procedures for Making Normal Concrete Mixture Plans. Jakarta: Republic of Indonesia*

Badan Standarisasi Nasional, *SNI 1974:2011. "Cara Uji Kuat Tekan Beton Dengan Benda Uji Silinder",* 2011.

National Standardization Agency, SNI 1974:2011. "How to Test Compressive Strength of Concrete With Cylindrical Test Objects", 2011.)

Badan Standarisasi Nasional, *SNI 15- 2049*: "*Semen Portland"*, 2004. *(National Standardization Agency, SNI 15-2049: "Portland Cement", 2004*).

Badan Standarisasi Nasional (BSN). 1989. SNI S-04-1989-F: Spesifikasi Bahan Bangunan Bagian A. Departemen Pekerjaan Umum. Jakarta. (*National Standardization Agency (BSN). 1989. SNI S-04-1989-F: Specifications for Building Materials Part A. Ministry of Public Works. Jakarta*.)

Badan Standarisasi Nasional, (2000), Standart Nasional Indonesia nomor 03- 2834-2000 tentang Tata Cara Pembuatan Rencana Campuran Baton Normal. Jakarta: Republik Indonesia. (*National Standardization Agency, SNI 03- 2834-2000 "Procedures for Making Concrete Mix Plans standard fc 29.05 mpa", 2000.*)

Badan Standarisasi Nasional, *SNI 1974:2011. "Cara Uji Kuat Tekan Beton Dengan Benda Uji Silinder",* 2011. (*National Standardization Agency, SNI 1974:2011. "How to Test Compressive Strength of Concrete With Cylindrical Test Objects", 2011*).

Badan Standarisasi Nasional, *SNI 03- 2834-2000 " Tata Cara Pembuatan Rencana Campuran Beton standar (National Standard number 03-2834-2000 concerning Procedures for Making Normal Concrete Mixture Design. Jakarta: Republic of Indonesia*).

Bacinskas D., Rumsys D., Kaklauska G. (2022) Numerical Deformation Analysis of Reinforced Lightweight Aggregate Concrete Flexural Members MDPI p.11,12 pp 1-13 Materials 2022, 15, 1005. https://doi.org/10.3390/ma15031005 https://www.mdpi.com/journal/materials

Ervianto, M., Saleh, F., Prayuda, H. 2016. Compressive Strength of High-Quality Concrete Using Fly Ash and Addictive Substances (Bestmittel). Journal of Synergy 20(3) 2016: 199-206. p-ISSN: 1410-2331 e-ISSN: 2460-1217 URL: http://publikasi.mercubuana.ac.id/index.php/sinergi Journal DOI: 10.22441/sinergi

Ervianto, M., Saleh, F., Prayuda, H. 2016. Kuat Tekan Beton Mutu Tinggi Menggunakan Bahan Tambah Abu Terbang (Fly Ash) dan Zat Adiktif (Bestmittel). Jurnal Sinergi 20(3) 2016 : 199-206p-ISSN : 1410=2331 e-ISSN : 2460-1217

Fauzi M.F, Nursyamsi(2014). Pemanfaatan Limbah Serbuk Kayu (Sawdust) Sebagai Subtitusiagregat Halus Pada Campuran Beton (*Utilization of Sawdust as Substitution of Fine Aggregate in Concrete Mixture From the results of testing the density of concrete*) Jurnal Teknik Sipil USU Home > Vol 3, No 2 (2014) abstract https://jurnal.usu.ac.id › index.php › jts › article › view

Luhar, I.; Luhar, S.; Abdullah, M.M.A.B. ; Nabiałek, M.; Sandu, A.V. ; Szmidla, J.; Jurczy ´nska, A.; Razak, R.A. ; Aziz, I.H. A; Jamil, N.H. ; et al. (2021) Assessment of the Suitability of Ceramic Waste in Geopolymer Composites: An Appraisal. Materials 2021, 14, 3279. 1 Publisher's Note: MDPI, 14 June 202I https://doi.org/10.3390/ma14123279 Conclusions (24,25 PP 1-30)

Marvila, M. T; de Azevedo, A.R.G. ; de Matos, P.R. ; Monteiro, S.N. ; Vieira, C.M.F. (2021), Materials for Production of High and Ultra-High Performance Concrete: Review and Perspective of Possible Novel Materials. Materials Conclusions (25:PP 1-36)

Ngadianto, A, Agustin, D. A (2015) Berat Jenis Dan Keteguhan Lengkung Statik Kayu Jati Dari Hutan Rakyat Yang Tumbuh Di Kecamatan Samigaluh, Kulon Progo (*Specific Gravity And Stability Of Teak*

Wood Static Flexure Persistance From Community forests Growing In Samigaluh District, Kulon Progo.) Pengelolaan Hutan skripsi D3 (2015)

Prayuda H (2018)_ Analysis of the Compressive Strength of High-Quality Concrete With Added Materials Superplasticizer and Carbide Welding Waste Rekayasa Sipil hhtp://rekayasa sipil. ub. C.id DOI: https://doi.org/10.21776/ub.rekayasasipil/2018.012.01.5 Vol 12, No 1 (2018)

Shah. J. H, Shah S. B(2014) Comparative Study Of Concrete Mix Design By Adding Various Types Of Admixtures *National Conference on Recent Advances in Civil and Structural Engineering (RACSE-'14). ISBN: 978-81-927554=1-0rganized by ADIT and BVM on 25th - 26th April 2014 ISBN: 978-81-927554-1-0 Vol.-I Page No. 228*-229 conclusion pp 225-229

SNI 03-6827-2002ASTM C403. C403 M=08,IDT) Metode Uji Waktu Pengikatan Beton dengan Ketahanan Penetrasi clause 12.2 (*Method of Testing Concrete Bonding Time with Penetration Resistance clause 12.2*)

Sugiharto (2021), Komparasi Hutan Alam dan Hutan Tanaman Indonesia: Majalah: Panduan Usaha Agribisnis, Kehutanan (*Comparison of Indonesian Natural Forests and Plantation Forests*) Magazine: Agribusiness, Forestry Business Guide, Sugiharto March 23, 2021)

Wichrowska K. K, Pawluczuk E, Bołtryk M, Jimenez J. R,*,†, Rodriguez J.M. F. Morales D. (2022)The Performance of Concrete Made with Secondary Products—Recycled Coarse Aggregates, Recycled Cement Mortar, and Fly Ash–Slag Mix p 19 (conclusion) pp1-20

Materials 2022, 15, 1438. 15 Feb 2022.https://doi.org/10.3390/ma15041438 https://www.mdpi.com/journal/materials (page 9)

Reference

Adinugraha, H. A., & Leksono, B. (2013). Kinerja Jati Asal Muna Pada Plot Uji Klon Jati di Empat Lokasi. *Jurnal Penelitian Kehutanan Wallacea*, *2*(2), 138. https://doi.org/10.18330/jwallacea.2013.vol2iss2pp138-153

Bacinskas, D., Rumsys, D., & Kaklauskas, G. (2022). Numerical Deformation Analysis of Reinforced Lightweight Aggregate Concrete Flexural Members. *Materials*, *15*(3). https://doi.org/10.3390/ma15031005

Ervianto, M., Saleh, F., & Prayuda, H. (2016). Kuat Tekan Beton Mutu Tinggi Menggunakan Bahan Tambah Abut Terbang (Fly Ash) Dan Zat Adiktif (Bestmittel). *Sinergi*, *20*(3), 199. https://doi.org/10.22441/sinergi.2016.3.005

Kalinowska-Wichrowska, K., Pawluczuk, E., Bołtryk, M., Jimenez, J. R., Fernandez-Rodriguez, J. M., & Morales, D. S. (2022). The Performance of Concrete Made with Secondary Products—Recycled Coarse

Aggregates, Recycled Cement Mortar, and Fly Ash–Slag Mix. *Materials*, *15*(4). https://doi.org/10.3390/ma15041438

Luhar, I., Luhar, S., Abdullah, M. M. A. B., Nabiałek, M., Sandu, A. V., Szmidla, J., Jurczyńska, A., Razak, R. A., Aziz, I. H. A., Jamil, N. H., & Deraman, L. M. (2021). Assessment of the Suitability of Ceramic Waste in Geopolymer Composites: An appraisal. *Materials*, *14*(12), 1–30. https://doi.org/10.3390/ma14123279

Marvila, M. T., De Azevedo, A. R. G., De Matos, P. R., Monteiro, S. N., & Vieira, C. M. F. (2021). Materials for Production of high and ultra-high performance concrete: Review and Perspective of Possible Novel Materials. *Materials*, *14*(15). https://doi.org/10.3390/ma14154304

Materials 2022, 15, 1438. 15 Feb 2022.https://doi.org/10.3390/ma15041438 https://www.mdpi.com/journal/materials

Ngadianto, A. (2015). *Berat Jenis dan Keteguhan Lengkung Statik Kayu Jati dari Hutan Rakyat yang Tumbuh di Kecamatan Samigaluh, Kulon Progo Dinar Ayu Agustin, Agus Ngadianto, S. Hut., M. Sc.* 1–2.

Shah, J. H., & Shah, S. B. (2014). Comparative Study of Concrete Mix Design by Adding Various Types of Admixtures. *© 2014 Ijedr*, *2*(3), 3190–3193. www.ijedr.org

Sugiharto (2021) ,Komparasi Hutan Alam dan Hutan Tanaman Indonesia: Majalah : Panduan Usaha Agribisnis , Kehutanan (*CoMParison of Indonesian Natural Forests and Plantation Forests*) Magazine: Agribusiness, Forestry Business Guide ,Sugiharto March 23, 2021)

SNI 03-2834-2000, (2000). Tata Cara Pembuatan Rencana Campuran Baton Normal. Badan Standarisasi Nasional Jakarta: Republik Indonesia. *(Indonesian National Standard number 03-2834-2000 concerning Procedures for Making Normal Concrete Mixture Plans. Jakarta: Republic of Indonesia. National Standardization Agency)*

SNI 1974:2011. (2011). Cara Uji Kuat Tekan Beton Dengan Benda Uji Silinder. Badan Standarisasi Nasional. (*SNI 1974:2011. How to Test Compressive Strength of Concrete With Cylindrical Test Objects, National Standardization Agency*).

SNI 15-2049. Semen Portland, 2004. Badan Standarisasi Nasional *(SNI 15-2049: "Portland Cement", 2004. National Standardization Agency*)*.*

SNI S-04-1989-F, (1989). Spesifikasi Bahan Bangunan Bagian A. Departemen Pekerjaan Umum Jakarta. Badan Standarisasi Nasional. (*SNI S-04-1989-F. Specifications for Building Materials Part A. Ministry of Public Works. Jakarta. National Standardization Agency*)

SNI 03-6827-2002. (2002). Pengujian Waktu Ikat Awal Semen Portland dengan Menggunakan Alat Vicat untuk Pekerjaan Sipil. Badan Standarisasi Nasional.

Figures

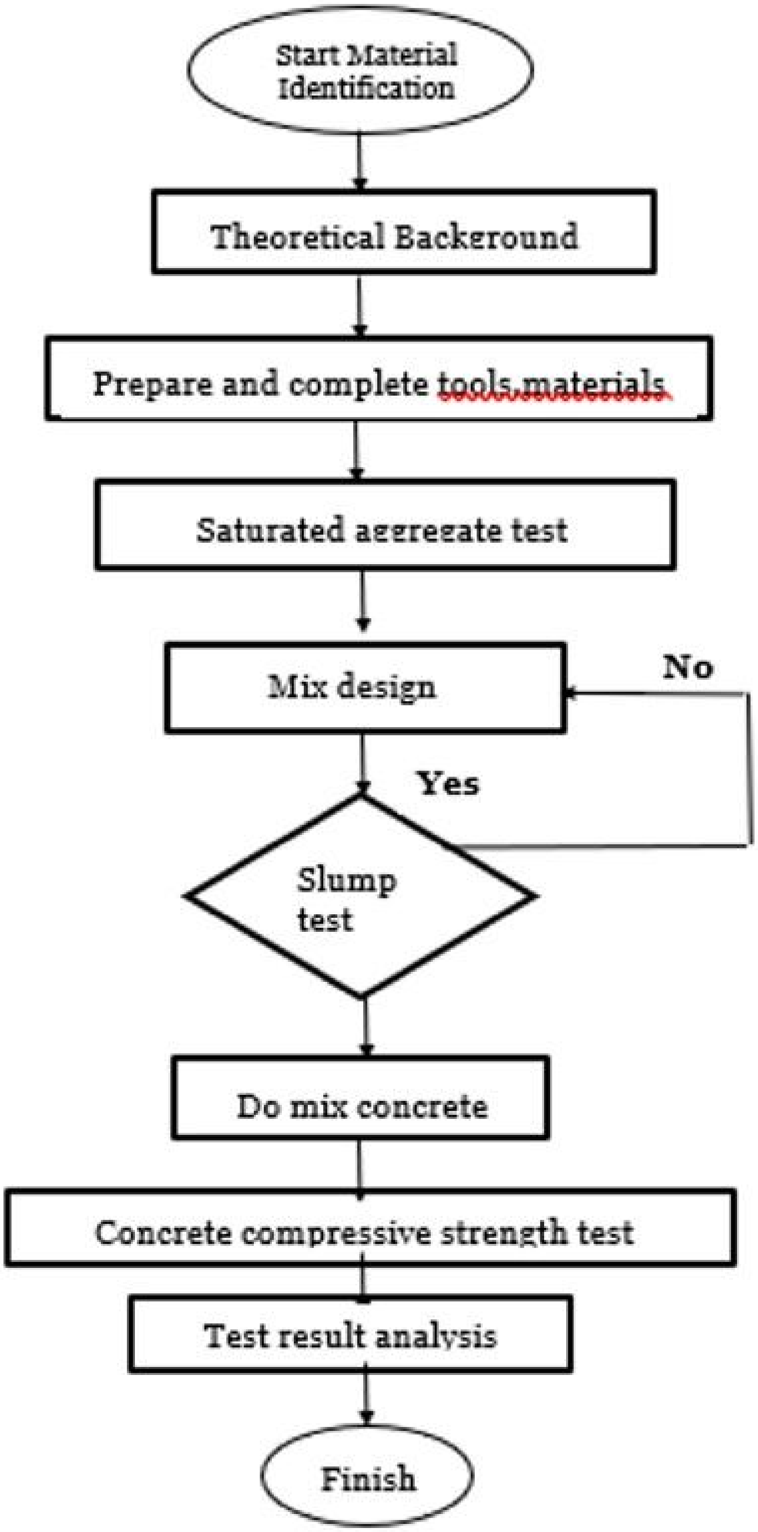


Figure 1

Concrete (Standard, Variations 1 and 2) Research Diagram

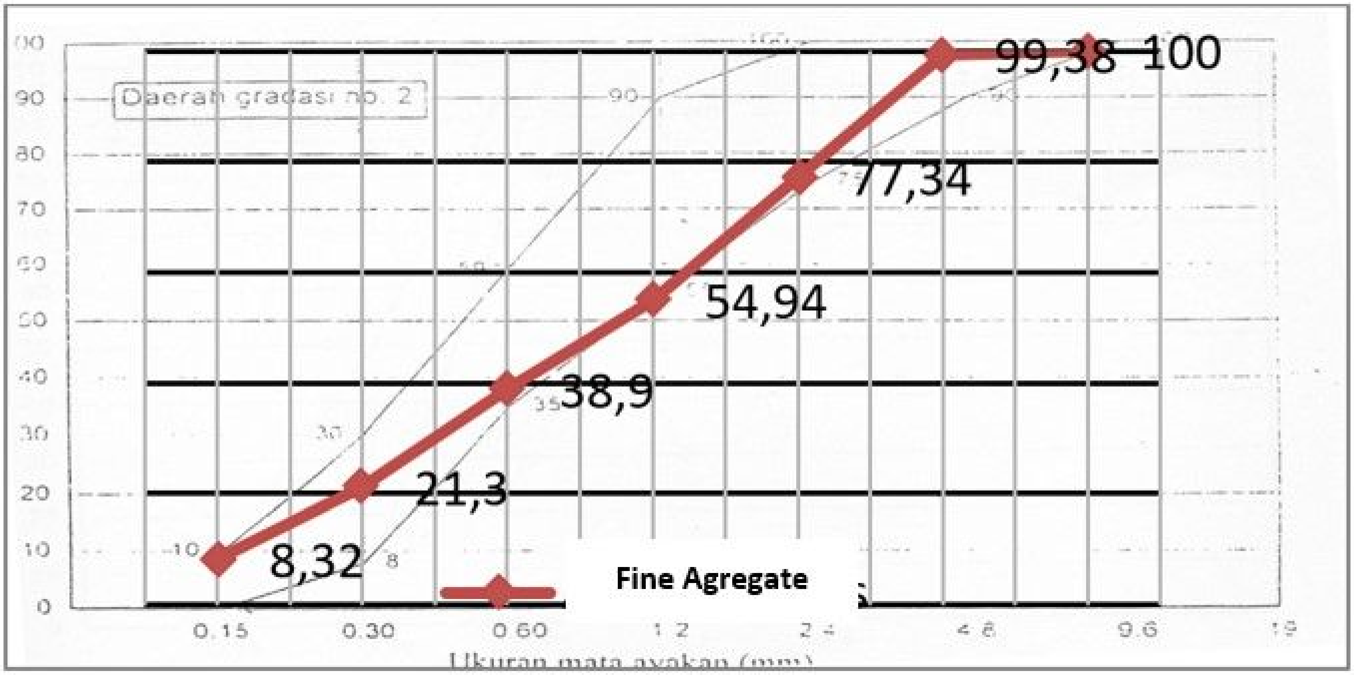


Figure 2

Fine Aggregate Gradation

Figure 3

Coarse Aggregate Gradation

Figure 4

Specify Gravity Test Process

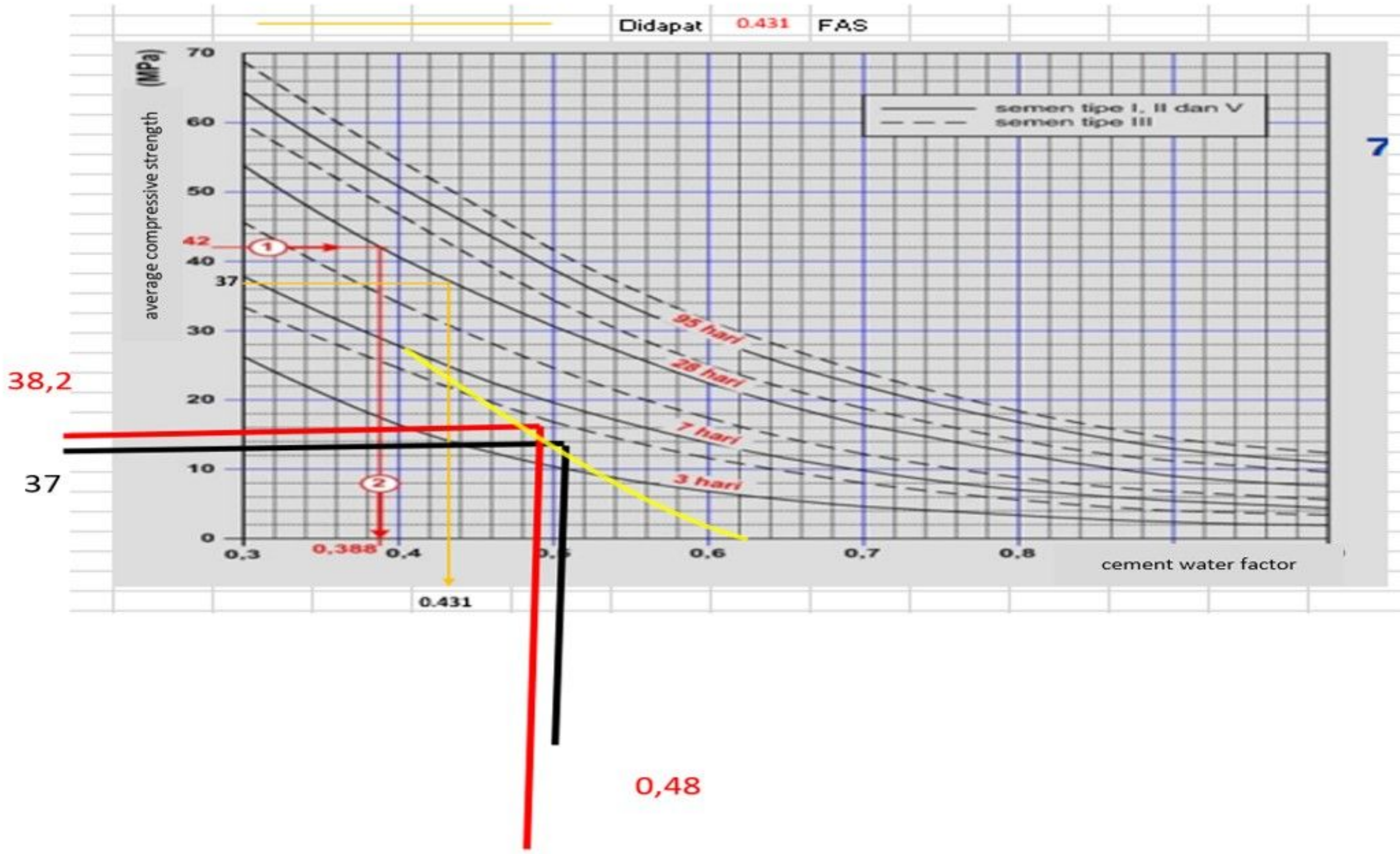
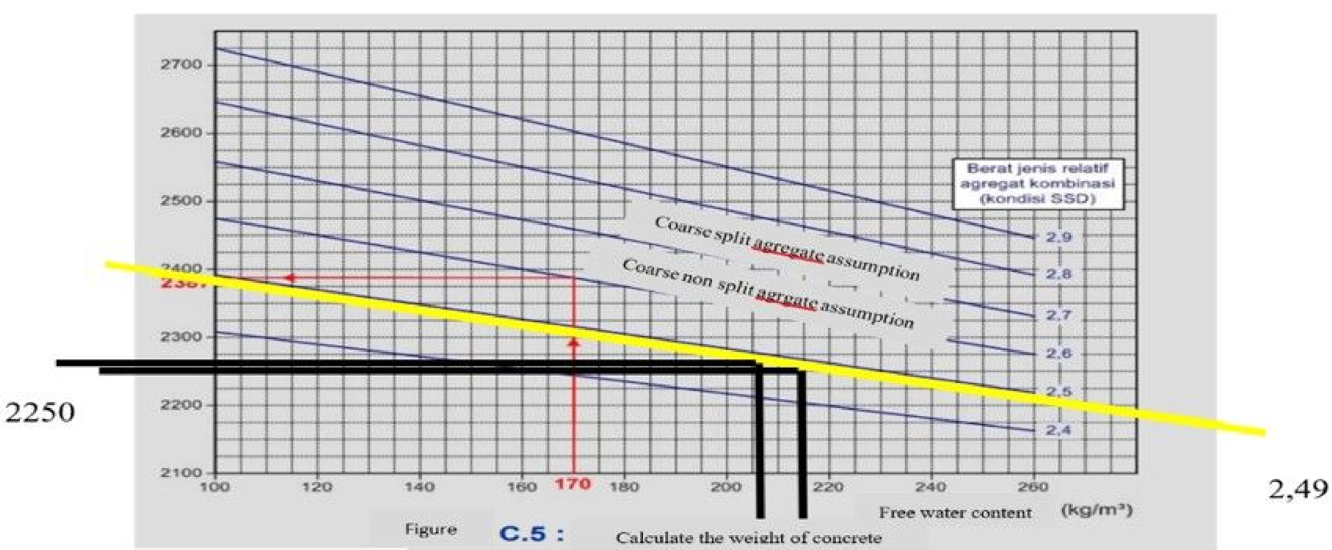


Figure 5

Grafik CWF / (cement water factor)



Sumber : Penulis

Figure 6

Concrete fill weight chart

Figure 7

Variation 1 concrete fill weight chart

Figure 8

Graph of Concrete Fill Weight Variation 2

Figure 9

Sample of Teak Wood and Lathe Iron Waste

Figure 10

Slump test Concrete standard fc 29.05 mpa

Figure 11

Slump test variation 1 Concrete standard fc 29.05 mpa

Figure 12

Slump test variation 2 Concrete standard fc 29.05 mpa

Figure 13

concrete test standard fc 29.05 mpa age 28 days

Figure 14

concrete test standard variation 1 , age 28

Figure 15

concrete test standard variation 2 , age 28 days

Figure 16

Comparison of the concrete compressive strength charts

Figure 17

Concrete standard age 7 days

Figure 18

Concrete standard age 21 days

Figure 19

Concrete standard age 28 days

Figure 20

Concrete variation 1 1 (teak wood 10% coarse aggregate) at 7 days

Figure 21

Concrete variation 1 (teak wood 10% coarse aggregate) at 21 days

Figure 22

Concrete variation 1 (teak wood 10% coarse aggregate)age 28 days

Figure 23

Concrete variation 2 age 7 days

Figure 24

Concrete variation 2 age 21 days

Figure 25

Concrete variation 2)age 28 days

Figure 26

The colapse of the 7-day standard concrete test

Figure 27

The collapse of 7-day variation 1 concrete test

Figure 28

The collapse after 7 days of variation for 2 concrete tests

Figure 29

Collapse of the 21-day standard concrete test

Figure 30

The collapse of 21-day variation 1 concrete test

Figure 31

The collapse of 21-day variation 2 concrete test

Figure 32

Collapse of the 28-day standard concrete test

Figure 33

Collapse after 28 days of variation for 1 concrete test

Figure 34

Collapse after 28 days of variation for 2 concrete tests