

CONCRETE MIX ANALYSIS WITH VOLUME RATIO AND OBSERVATION OF MEDIUM STRENGTH CONCRETE CHARACTERISTICS IN THE CONSTRUCTION OF MIPA FACULTY BUILDING PATTIMURA UNIVERSITY

Abraham Tuanakotta

Diploma 3 Of Civil Engineering Study Program, Politeknik Negeri Ambon
Email: tuanakottaabraham@gmail.com

ABSTRACT

The need for concrete in a project is not only in large volumes, but also in small volumes. In large volumes, the fulfillment of concrete needs in a project can be done by ordering to concrete suppliers in the form of readymix concrete. Concrete batching plants are used for concrete production of all kinds of projects such as roads, bridges, dams, airports, etc. They can be equipped with one mixer or more in various capacities. The concrete mixes in the project with a volume ratio of 1:1.5:2.5 (cement: sand: crushed stone) with FAS values (0.43-0.47) for concrete quality ranging from K250 - K300. Based on this, this research aims to get the composition of the concrete mixture using a volume ratio for different FAS values and get its compressive strength. The method used in this research is the experimental method, namely planning the composition of the concrete mixture with a volume ratio of 1: 1.5: 2.5 (cement: sand: crushed stone) with FAS values (0.43-0.47) testing the compressive strength of the concrete cube test samples. With the results of the concrete compressive strength test for FAS 0.43, namely 270.525 Kg / cm³ and for FAS 0.47, namely 264 Kg / cm³.

Keywords: Concrete, compressive strength, mix composition

INTRODUCTION

Concrete is a mixture of fine aggregate and coarse aggregate as filler. In addition, cement and water are used as binders or additives. Nowadays, concrete is widely used for construction. One of the advantages of concrete is its compressive strength which is much greater than its tensile strength. Thus the compressive strength is a mechanical characteristic that is more important to consider than the tensile strength. The maximum concrete strength is defined as the maximum compressive stress that the concrete material can withstand due to external loads. The concrete batching plant, also known as concrete mixing plant, is a device that homogeneously combines various ingredients to form concrete. We are a family owned business and have been involved in supplying ready-mix concrete batching plants and equipment to the industry over the last 25 years.

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A concrete plant, also known as a batch plant or batching plant or a concrete batching plant, is equipment that combines various ingredients to form concrete. The implementation of the concrete mixture in the UNPATTI Mipa Faculty Building Construction project is carried out in stages with small volumes, mixing concrete directly in the field without ordering through

supplier orders. The implementation of the concrete mixture in the project with a volume ratio of 1: 1.5: 2.5 (cement: sand: crushed stone) with a FAS value (0.43-0.47) Based on the above comparison, the authors want to know the difference between the two comparisons and can find out the strength of the two test objects and can find out the volume comparison by observing the characteristics of the concrete when testing the test objects.

Problem Limitations in this study are as follows: **(1)** *The constituent materials used in this study are:* (a) The fine aggregate used is river sand (sand from passo big water), (b) Proland cement used is Tonasa cement, (c) The coarse aggregate used is crushed stone size $\frac{1}{2}$ of the laha, and (d) The water used is working water in the laboratory. **(2)** *The test objects used are 15x15x15cm cubes totaling 3 pieces.* **(3).** *Concrete mix planning is done by volume comparison.* **(4).** *The test used is testing the compressive strength of concrete at the age of 28 days for test objects that use unwashed material.* **(5).** *The quality of the test specimens used is medium quality concrete, which is in the range of K250-K300.* **(6).** *The specimens were made without using any additives.* **(7).** *Comparison of materials used:* Portland cement: sand: Aggregate and FAS value comparison. The proportion of concrete mix is 1:1.5:2.5 with FAS value (0.47 to 0.43).

Based on the background of the above problems can be formulated as follows: (1) How is the composition of the concrete mixture by using volume ratio for different FAS values, (2). How is the compressive strength of concrete from the composition of concrete mixtures using volume ratio for different FAS values. The objectives of this paper include what is to be achieved and what is the target of the research: (1). To obtain the concrete mix composition using volume ratio for different FAS values. (2). To obtain the concrete compressive strength of the concrete mix composition using volume ratio for different FAS values.

RESEARCH METHOD

This research was conducted in the Civil Engineering Laboratory of Ambon State Polytechnic which is in accordance with National Standards. The types of data used in this paper is Secondary Data, where the data is obtained from literature studies, such as books, papers, journals, previous research and can be data that can be processed and can also be data from the project. The data used by the authors in this study are primary data (direct) from the results of laboratory research and secondary data in the form of literature studies.

Data collection techniques by Library research. That research data is conducted using literature (literature), both in the form of books, notes, and reports on previous research results. The data obtained for this author comes from the library method, from the results of experiments in the laboratory. The method used in this research is the experimental method, which is an experiment that aims to determine the characteristics of concrete and the compressive strength of concrete test objects made in this experiment, namely in the form of concrete cubes which will later be tested for compressive strength and characteristics.

1. Tools used

Sieve for coarse aggregate 1 $\frac{1}{2}$ ", 1, $\frac{3}{4}$ ", 4"



Image of coarse sieve

Sieve for fine aggregate No. 10,20,40,50,80,100,200 and pan



Fine Sieve Picture

Cement scoop



Image of cement scoop

Digital scales



Image of Digital Scale

Oven



Image of Oven

Sieve shaker



Image of Sieve Shaker

The saucer



Image of The Saucer

Brush



Image of Brush

2. Material.

Sand (fine aggregate)



Image of Sand (fine aggregate)

Gravel (coarse aggregate)



Image of Gravel

3. Implementation procedure

1. Fine Aggregate

Prepare the equipment and materials required for this test. Weigh 2000 g of fine aggregate. Dry the aggregate in an oven for ± 24 hours. Put the fine aggregate into sieve No. 10 to 200 and pan. Vibrate the sieve with a sieve shaker for 5 minutes. Each aggregate retained on the sieve is weighed with a digital scale.

2. Coarse aggregate

Prepare the equipment and materials required for this test. Weigh the coarse aggregate as much as 3000 g. Dry the aggregate in an oven for ± 24 hours. Put the coarse aggregate into a 1 ½" to 4" sieve and pan. Vibrate the sieve with a sieve shaker for 5 minutes. Each aggregate retained on the sieve is weighed with a digital scale.

ANALYSIS AND DISCUSSION

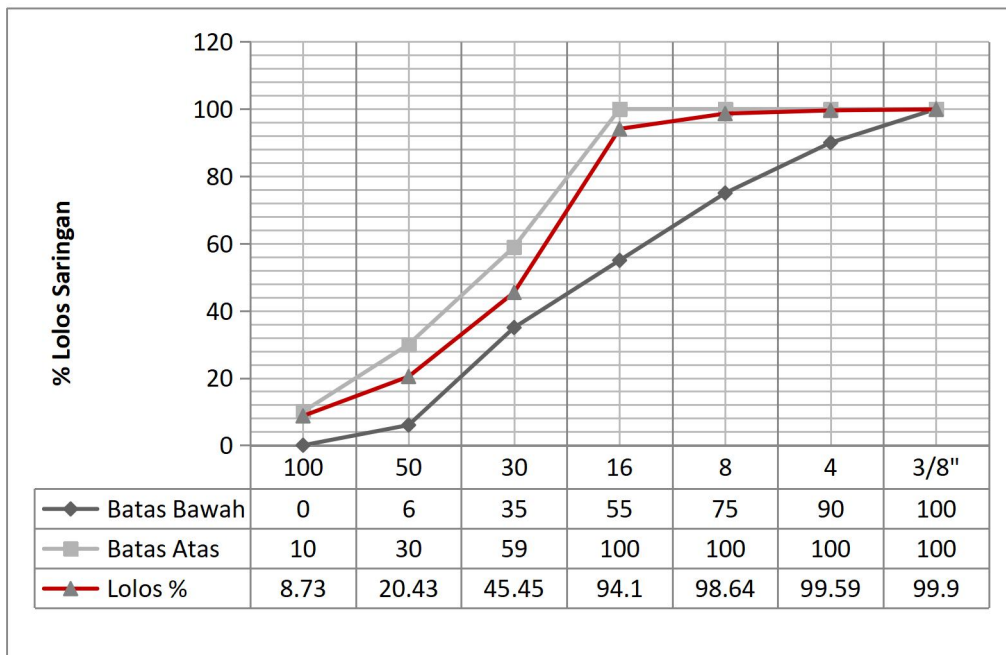
Material Testing Results

1. Fine Aggregate Results

a. Fine Aggregate Gradation

Sample Type: Natural Sand						
Sample Source: passo						
No. Sieve	Weight Sieve	Weight Sieve+ Retained Material	Weight Retained	Weight Cumulative	Percentage (%)	
1	2	3	4 = (3 - 2)	5	6 = $\frac{5}{\Sigma 5} \times 100\%$	7 = $100\% - 6$
4	412.73	564.75	152.0	152.0	100.000	-
10	423.4	586.2	162.8	314.8	0.240	99.76
20	411.4	615.2	203.8	518.6	24.780	75.22
40	411.7	661.6	249.9	768.4	36.720	63.28
50	403.9	910.9	507.0	1,275.4	60.940	39.06
80	405.6	725.2	319.6	1,595.0	76.210	23.79
100	382.1	698.4	316.3	1,911.3	91.330	8.67
200	398.3	528.1	129.8	2,041.1	97.530	2.47
Pan	452.3	504.0	51.7	2,092.7	100.00	
					487.750	
Modulus of Smoothness : $469.53/100 =$					4.878	

Fine aggregate gradation table



b. Water Content of Fine Aggregates

In testing the water content of sand, an average value of 1.05% was obtained. This condition shows that the sand is under normal conditions, where the water content requirements for fine aggregates range from 1% - 2%. Water content will affect the compressive strength value. The higher the water content, the greater the absorption capacity of the aggregate and affects the compressive strength of the concrete. The complete inspection results can be seen in the appendix

c. Specific gravity and water absorption

From the test, the average value of the specific gravity of saturated surface dry is 2.47. And the absorption value is 5.28. The complete inspection results can be seen in the appendix

d. Mud content of fine aggregate

Based on the results of the research of fine aggregate mud content obtained an average of 4.34% smaller than the value of mud content in normal concrete which is 5% in accordance with this causes the sand can be directly used without having to be washed first.

2. Coarse Aggregate Results

a. Mud content of coarse aggregate.

The gravel used in this study was washed first to remove the mud content and dirt attached to the gravel. The mud content of coarse aggregates obtained an average value of 8.6%, exceeding the standard value set at 1%. So the fine aggregate can be washed first

b. Specific gravity of coarse aggregate

The specific gravity of face-dried saturated crushed stone was found to be 2.38, so it can be classified as a normal aggregate between 2.5-2.7.

Results of Mix Design

The calculation method used in concrete mix planning is the SNI 03-2834-2000 method. The stages carried out in planning the concrete mixture are as follows:

1. **Setting the concrete compressive strength (f'_c) at the age of 28 days** . The planned concrete compressive strength at the age of 28 days is 24.90 MPa
2. **Determine the standard deviation value (S)**. The standard deviation is calculated based on the volume of concreting to be made and the quality of the work. The standard deviation value used in the planning of this mixture is 7 MPa, which is a poor level of quality control work because it has not had previous experience. Seen in Table 2.2
3. **Calculating the added value (Margin)**. $M = 1.64 \times 7 = 11.48 \approx 12$ MPa
4. **Calculating the targeted average concrete compressive strength (f'_{cr})** . $f'_{cr} = f'_c + M$. $= 24,90 + 12$; $f'_c = 36.9$ MPa.
5. **The type of cement** specified is composite Portland cement whose use does not impose any special requirements, so it is the same as type 1 cement.
6. **The type of fine aggregate** used is natural, using sand from Passo.
7. **The type of coarse aggregate** used is PT Prima crushed stone with a max size of 40 mm.
8. **Determine the value of cement water factor** by using the following graph of 'relationship between average compressive strength and cement water factor based on age of specimen and type of cement'. **(a)**.The estimated compressive strength from the table can be determined from the type of cement, the type of aggregate the specimen forms used and the age of the concrete at compressive strength. See Table 2.3 Estimated compressive strength (MPa) of concrete with a cement water factor of 0.47 and coarse aggregate commonly used in Indonesia. From the table above, it is found that the compressive strength is 37 MPa. **(b)** After that look at the figure that is about the relationship between the average compressive

- strength and cement water factor with a cube-shaped test object. (c). Make a perpendicular line up through the cement water factor of 0.47 until it cuts the curve in red, then make a straight line to the right from the number 24.90 MPa until the line touches the red line (d). Then draw a curved line through the intersection point of sub. Item b proportionally (e). Then draw a straight line to the right from the fcr number of 62 MPa until it touches the curved line (new curve) that has been made or determined from sub. item c above. (f) Then make a straight line down through the intersection point. Then from the line obtained fas value of 0.43 and can be seen in Figure 2.6.
9. **Determining the maximum cement water factor value.** After determining the fas value from the figure above, then proceed with determining the maximum cement water factor (fas) which can be determined from the table Table 2.4 fas requirements and the minimum amount of cement for sharing concreting and special scope
 10. **Setting the slump value.** The planning slump height set is 60-180mm.
 11. **Setting the maximum aggregate grain size.** The max aggregate grain size used is 40 mm.
 12. **Determining the free water content .** The free water content can be determined from the table using the data of maximum aggregate size, artificial type, and plan slump. After obtaining the results of the estimated water demand per cubic meter of concrete, then the amount of water demand can be calculated using the equation . Seen in Table 2.5 the estimated water requirement per cubic meter of concrete . $W = W_h + W_k$; $= 175 + 205$; $= 185$ kg. From the above calculations, the value of the free water content is equal to 185 kg.
 13. **Calculating cement requirement.** The amount of cement required is calculated based on the equation $W_{semen} = 430$ kg. From the above calculation, it is obtained that the amount of cement needed is 430 kg.
 14. **Determining the cement requirement used .** After calculating the cement requirement with the equation, it is necessary to find the minimum cement requirement by looking at the fas requirement table from the table, the minimum cement requirement value is 325 kg. if the cement requirement obtained from the calculation turns out to be less than the minimum cement requirement based on the fas requirement table, the cement requirement with the largest value of the two methods is used.
 15. **Determining the percentage of fine and coarse aggregates.** The percentage of fine and coarse aggregate is determined by the maximum size of the coarse aggregate, the slump value, the water-cement factor, and the gradation region of the fine aggregate. To determine the percentages of fine aggregate can be seen in the figure because the maximum grain size used is 40 mm and the slump used is 60-180 mm. In addition, the gradation area number 2 is used which is the result of the fine modulus testing of fine aggregate grains. (a) Draw a straight line upwards through the previously obtained cement-water factor of 0.43 until it intersects the upper curve of gradation number 2. (b) f. Then from the point of intersection of the upper curve and the lower curve at gradation number 2, draw a horizontal line to the left until it intersects the vertical axis. (g) . From the drawing of the upper and lower lines, the figures of 36.5 and 29.5 can be seen in Figure 2.7. ; (h) The penetrase value of fine and coarse aggregates can be calculated by using the formula below. Percentage H = 33% ; %AK = 100% - %AH ; 100% - 33% ; %AK = 67% . From the above calculation, the percentage value of fine aggregate (%AH) is 33% and coarse aggregate (%AK) is 67%.
 16. **Calculate the SSD specific gravity of the combined aggregates..** The SSD specific gravity of fine and coarse aggregates can be determined from the SSD type tests of fine and coarse aggregates described in the SSD testing report. From the specific gravity tests, the specific gravity of fine aggregates (BJAH) is 2.6 and the specific gravity of coarse aggregates (BJAK) is 2.58. After obtaining the specific gravity of the two aggregates, the specific gravity of the combined aggregate can then be calculated using the equation Combined BJ

= %AH x BJAH + %AK x BJAk ; = 33% x 2.58 + 67% x 2.6 ; = 2,587. From the above calculation, the specific gravity of the combined aggregate (BJabungan) is 2.587.

17. **Determining the concrete content weight .** The wet concrete content weight is determined based on the graph in Figure by combining the specific gravity of the combined aggregates and the free water content (a) Create a new curve according to the specific gravity of the combined aggregates in proportion to the existing upper and lower curves. (b) Then draw perpendicularly upwards from the applied water content of 205 kg/m³ until it intersects the new curve of combined specific gravity, (c) Then from the intersection point, draw a horizontal line to the left until it intersects the vertical axis. (d) From the drawing of the line, the value of the concrete content verat is 2358 seen in Figure 2.8.
18. **Calculating the proportion of concrete mix.** A concrete plant, also known as a batch plant or batching plant or a concrete batching plant, is equipment that combines various ingredients to form concrete. The proportion of fine aggregate can be found using the equation and to calculate the proportion of coarse aggregate can be used the equation .
 $WAH = (W \text{ wet concrete content} - W \text{ cement} - W \text{ water}) \times \%AH ; = (2,358 - 476 - 185) \times 33\% ; = 217.35 \text{ kg/m}^3$
 $WAK = (W \text{ content of wet concrete} - W \text{ cement} - W \text{ water}) \times \%AH ; = (2,358 - 476 - 185) \times 67\% ; = 441.29 \text{ kg/m}^3$

Mix Design of K-300 Concrete Design Mix

A. Mix Design with FAS Value (0.43)

No	Description	Remark	Value		
1	Required compressive strength	Specified	K -300 Kg/Cm³ at 28 days of age, Defective part: 5% (k=1,64)		
2	Standart deviation	Definet PBI	7 Mpa (N/mm²)		
3	Added Value (margin)	P1	1,64 x 7 = 11.5 Kg/Cm²		
4	Targeted average strength	P2	300 + 11.5 = 311.5 Kg/Cm²		
5	Type of cement	Specified	Type 1		
6	Type of coarse aggregate , Type of fine aggregate.	Specified	Defined Crushed stone Natural sand		
7	Water factor of cement (FAS) Free	Teble & grafic	0,43		
8	Water cement factor (FAS) Max	Specified	0,47		
9	Slump	Specified	60 – 180 mm		
10	Specified Max grain size	Specified	40 mm		
11	Table free water content	Table	185 Kg/Cm³		
12	Amount of cement	P3	185 : 0,43 = 430.23 = 430 Kg/Cm³		
13	Amount of cement Max		430 Kg/Cm³		
14	Amount of cement Min	Table	275 Kg/Cm³		
15	Adjusted cement water factor		-		
16	Grain size arrangement of fine aggregates	Graphics	Zone 2		
17	Coarse or combined aggregate arrangement	Graphics	Batas gradasi untuk ukuran max 40 mm		
18	Percent fine aggregate	Graphics	0,33%		
19	Specific gravity of concrete	Diketahui	2.47		
20	Concrete content	Graphics	2550 Kg/Cm³		
21	combined aggregate content	P4	2550 – 185 – 430 = 1935 Kg/Cm³		
22	fine aggregate content	P5	0,33 x 1935= 638.55 Kg/Cm³		
23	Fine aggregate content	21 -22	1935 – 638.55 = 1296.45 Kg/Cm³		
Cement mix proportion		Cement (Kg)	Water (Ltr)	Fine Aggregate (Kg)	Aggregate Coarse(Kg)
Per m³		430	185	638.55	1296.45
Comparison		1	0.43	1.4732	2.5125

Conclusion: For 1m³ of concrete (2550 Kg) required: (a) Water = 205 liters , (b) Cement = 430 kg (8.6 bags), where 1 bag = 50 kg, (c) Sand = 650.76 kg , (d) Coarse aggregate = 1321.24 kg

Evaluation of aggregate characteristics check

1. Fine aggregate

Sample Type : PNatural Sand				
Sample Source : Passo				
No.	Test Description	Result Test	Spesification	Standart Based
1	Gradation			
	- Gradation zone	Zona 2	Zona 1 - 4	SK.SNI T.15-1990-03
	- Subtlety Model	4.88	1.5 - 3.8	SII 0052-80
2	Volume Weght (gr/cm3)		1.2 - 1.7	ASTM C-29
	- Free	0.03		
	- Solid	0.00		
3	Specific gravity and absorption		2.4 - 2.9	BS 812
	- Bulk Specific Weight	2.34		
	- SSD Specific gravity	2.47		
	- Apparent Specific gravity	2.69		
	- Absobtion (%)	1.63	< 5%	PB-0203-80
4	Water Content (%)	0.05	< 5%	SII 0052-80
5	Mud Content (%)	7.60	< 5%	SII 0052-80

2. Coarse aggregate

Sample Type : Broken Stone						
Sample Source : PT Primah						
No.	Test Description	Test Results			Spect	Standart Based
		Aggregates I	Aggregates II	Mixed		
1	Gradation					
	- Zona of Gradation	-	-	Uk. Max 40 mm	Max 10-40 mm	SK.SNI T.15-1990-03
	- Subtlety Model	2.84	7.84	6.34	5 - 8	SII 0052-80
2	Berat Volume (gr/cm3)				1.2 - 1.7	ASTM C-29
	- Free	0.03	1.34	0.94		
	- Solid	0.04	1.52	1.07		
3	Specific gravity and absorption				2.4 - 2.9	BS 812
	- Bulk Specific Weight	2.29	2.26	2.27		
	- SSD Specific gravity	2.38	2.36	2.37		
	- Apparent Specific gravity	2.51	2.53	2.52		
	- Absorbition (%)	5.13	4.74	4.86	< 5%	PB-0203-80
4	Water Content (%)	0.02	3.33	2.34	< 5%	SII 0052-80
5	Mud Content (%)	1.089	2.55	2.11	< 5%	SII 0052-80

Volume comparison

a. Fas (0.43).

	Weight (kg)	content weight(kg/dm^3)	Volume (dm^3)	Ratio
Water	185	1	185	
Cement	430	1.25	344	1
Sand	638.55	1.26	506.7857143	1.473214286
Coarse Aggregate	1296.45	1.5	864.3	2.5125

c. Fas (0,47)

	Weightt (kg)	Content Weight(kg/dm ³)	Volume (dm ³)	Ratio
Water	205	1	205	
Cement	430	1.25	344	1
Sand	629.97	1.26	499.9761905	1.453419158
Coarse Aggregate	1279.03	1.5	852.6866667	2.47874031

sand loose content weight = 0.00126 kg/cm³

=

1.26 kg/dm³

Loose content weight Coarse aggregate = 0.0015 kg/cm³

= 1.5 kg/dm³

Mixture ratio 1 : 1,5 : 2,5

Concrete Cube Testing Results

Test Item No.	Date		Concrete Age	Cube Dimensions		Sample Weight	load	Extensive	Crushed Compressive Strength	Average compressive strength	Koef.	28-Day Aged Crush Press
	Casted	Tested		Wide	Hight							(Kg/cm ²)
			(Hari)	(cm)	(cm)	(Kg)	(KN)	(cm ²)	(Kg/cm ²)			
1	10 august 2020	17 august 2020	7	15.00	15.00	8.08	383	225	173.70	270.525	0.65	267.22
2	10 august 2020	17 august 2020	7	15.00	15.00	7.99	394	225	178.68	264	0.65	274.90
3	10 august 2020	17 august 2020	7	15.00	15.00	7.79	387	225	175.51		0.65	270.02
4	10 august 2020	17 august 2020	7	15.00	15.00	7.99	369	225	167.35		0.65	257.46
5	10 august 2020	17 august 2020	7	15.00	15.00	7.90	390	225	176.87		0.65	272.11
6	10 august 2020	17 august 2020	7	15.00	15.00	7.87	380	225	172.34		0.65	265.13

CONCLUSIONS

Based on the research, analysis, and discussion that has been presented, the following conclusions can be drawn: (1) The results of the composition of the concrete mixture using a volume ratio of 1: 1.5: 2.5 for FAS 0.43 and FAS 0.47, (2) The compressive strength of concrete for FAS 0.43 is 270.525 Kg / cm³ and for FAS 0.47 is 264 Kg / cm³. Suggestions are : (1) It is necessary to monitor the quality of the material.(3) Accuracy in research is very necessary starting from preparation, making to testing. (3).It is necessary to conduct further research using concrete constituent materials that meet all specifications.

REFERENCES

- Agus Setiawan, 2016, Perancangan Struktur Beton Bertulang* (Berdasarkan SNI-2847:2013), Penerbit ERLANGA, Jakarta
- Edward G Nawy, 2010. Beton Bertulang* (Suatu Pendekatan Dasar), Penerbit PT REFIKA ADITAMA, Bandung
- Ir. Tri Mulyono, 2005, *Teknologi Beton*, penerbit Andi, Yogyakarta
- Pujo Aji , Rachmat Purwono, 2011, *Pemilihan Proposi Campuran Beton* (concrete Mix design) sesuai ACI, SNI dan ASTM, ITS Press- Surabaya
- Pujo Aji , Rachmat Purwono, 2010, *Pengendalian Mutu Beton*, ITS Press- Surabaya
- Tjokrodinuljo, K., 2007, *Teknologi Beton*, Fakultas Teknik UGM, Yogyakarta
- SNI 03-2834-2000, *Tata Cara pembuatan rencana campuran beton*, Badan Standar Nasional.
- SNI 03-1974-1990 *Metode Pengujian Kuat Tekan Beton*, Badan Standar Nasional
- SNI 03-2847-2019 *Persyaratan Beton Struktural untuk Bangunan Gedung*, Badan Standar Nasional
- SNI 15-2049-2004, *Sement Portland*, Badan Standar Nasional