EVALUATION OF SEKOLAH ISLAM TERPADU (SIT) ALIYA BOGOR BUILDING STRUCTURE SYSTEM BASED ON THE REQUIREMENTS OF SNI 2847:2019

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ABSTRACT

Sekolah Islam Terpadu (SIT) Aliya Bogor is located in west Bogor district, Bogor city, West Java, was founded in 200, thus the standards used by planning consultant in building planning using old standard, where these standards have been updated with current standard, namely SNI 2847:2019. The evaluation carried out in this study based on requirements SNI 2847:2019 knowing the outcome of building that was said to be safe used help software ETABS) and SpColumn. Length of building of Umar Bin Khatab A and B are 18,60 meter;23,65 meter.Building area of building Umar Bin Khatab A and B are 541,26 m^2; 865,59 m^2. Concrete quality assessment (fc') that came from the test of hammer test column elements, beam elements, and plate elements as big 23,74 Mpa;26,59 Mpa;26,59 Mpa. After analysis some of to experience overstrength. The original column dimension In Building of Umar Bin Khatab A was K25x25 with shear reinforcement is Ø16-150 enlarge to K40x40 with shear reinforcement is Ø39-150 and beam dimension 20x40 enlarge to 35x55. On the building of Umar Bin Khatab B was K25x25 with shear reinforcement Ø16-150 enlarge to K40x40 with shear reinforcement Ø25-150, with the original beam dimension 20x40 enlarge to 30x55. The cost budget in the building of Umar Bin Khatab A is Rp 74.158.600,00 and in building of Umar Bin Khatab B is Rp 61.084.600,00.

Key word: SNI 2847:2019, evaluation of the structure; column; beam; SIT Aliya.

INTRODUCTION

Sekolah Islam Terpadu (SIT) Aliya Bogor is located at Jalan Gardu Raya, RT 03/RW 11, Bubulak, Kecamatan Bogor Barat, Kota Bogor, Jawa Barat 16115 has several building used for Kindergarden and Elementary Schools. In this study, the building will be evaluated named Gedung Umar Bin Khatab. Umar Bin Khatab Building itself is divided into two, namely Umar Bin Khatab A and Umar Bin Khatab B which are adjacent but not connected, each of which consists of 3 floors.

Sekolah Islam Terpadu (SIT) Aliya Bogor which was founded in 2001, thus the standards used by the planning consultants in building used the old standars, where these standards have been updated with the current standards, namely SNI 2847:2019.

Reinforced concrete structre are combination of several components which are one and the other interrelated in carrying the existing loads, which later on these components are designed carefully, following the applicable regulations, in this case SNI 2847:2019 in order to create a building that is safe, namely in accepting current loads or need to be reinforced with load so that the structure is able to withstand the load. By modeling the building structure using the help of software ETABS (*Extended Three Dimensional Analysis of Building Systems*) and *SpColumn*.

The purpose of this study was to evaluate the beams and columns of the concrete structure of Umar Bin Khatab A and Umar Bin Khatab B Buikding in Sekolah Islam Terpadu (SIT) Aliya Bogor based on the requirements of SNI 2847:2019 so as to know the results of a building for structural reinforcement using the ETABS and SpColumn.

The research limitation only includes the following, the evaluation is carried out only on exixting structure of UmaBin Khatab A Building and Umar Bin Khatab B Building in Sekolah Islam

Terpadu (SIT) Aliya Bogor with reference to SNI 2847:2019. Only the uildng beams and columns are reviewd. Analitycal modeling uses ETABS and SpColumn software to help analyze the atrength of the exixting structure of the Umar Bin Khatab A and Umar Bin Khatab B Building.

In Article 4.14 in SNI 2847:2019 evaluation of existing buildings must follow Article 27. The requirements in Article 27 for the evaluation of the strength of the existing structure through physical load submission only explain for the evaluation of structure with gravity loads only. Article 27 also describes the evaluation of analysis which can be applied to both gravity loads and other loads such earthquakes and winds.

Columns are structures that support axial loads with or without bending moments. In the superstructure, the column is the most important structural component to pay attention to, because if this column fails, it can result in the collapse of the structure of the building as a whole (Ali Asroni, 2010). In Article 10.5 of SNI 2847: 2019 it is explained that for each fixed factor load combination, the design strength in all sections must meet $\emptyset Sn \geq U$, including a) to d). the interaction between load effects must be:

$$a) \emptyset P_n \geq P_u$$

$$b) \emptyset M_n \geq M_u$$

$$c) \emptyset V_n \geq V_u$$

$$d) \emptyset T_n \geq T_u$$

Table 1. Transverse Reinforcement for Special Moment Bearer Frame System Columns

Transverse Reinforcement 1	Condition	Equations that Apply	
Ash/Sbc for square restraint stirrups	$P_u \leq 0{,}3A_g f_c'$ and $f_c' \leq 70 MPa$	Biggest among (a) and (b)	$0{,}3 \left(\frac{A_g}{A_{ch}} - 1 \right) \frac{f_c'}{f_{yt}}$ (a) $0{,}09 \frac{f_c'}{f_{yt}}$ (b)
	$P_u > 0{,}3A_g f_c'$ or $f_c' > 70 MPa$	Biggest among (a), (b), among (c)	$0{,}2 k_f k_n \frac{P_u}{f_{yt} A_{ch}}$ (c)
ρ_s for spiral or circular stirrups	$P_u \leq 0{,}3A_g f_c'$ and $f_c' \leq 70 MPa$	Biggest among (d) and (e)	$0{,}45 \left(\frac{A_g}{A_{ch}} - 1 \right) \frac{f_c'}{f_{yt}}$ (d) $0{,}12 \frac{f_c'}{f_{yt}}$ (e)
	$P_u > 0{,}3A_g f_c'$ or $f_c' > 70 MPa$	Biggest among (d), (e) and (f)	$0{,}35 k_f k_n \frac{P_u}{f_{yt} A_{ch}}$ (f)

Source: SNI 2847:2019

A beam can be defined as one of the elements of a portal structure with a horizontal direction, while the portal is the main frame of a building structure, especially buildings. This reinforcement is in the form of longitudinal or longitudinal reinforcement (which withstands bending loads) and shear reinforcement (which resists shear and torsional loads) (Ali Asroni, 2010). Article 9.4.2 SNI 2847: 2019, for a beam built together with the pedestal, Mu (Factor Moment) on the pedestal is permitted to be calculated on the face of the pedestal. Article 9.4.3 SNI 2847: 2019, for a beam

built together with the pedestal, Vu on the pedestal is permitted to be calculated on the face of the pedestal. The sections between the support face and the critical section located d from the support face for non-stressed beams or h / 2 from the support faces for prestressed beams shall be designed to meet Vu at the critical section if a) to c) are met:

a) Support reaction, in the direction of the shear that occurs, causes pressure to the end of the beam.

b) The load is applied to or near the top surface of the beam.

c) There is no centralized load of the focus interface and the critical cross section.

Article 9.5 SNI 2847: 2019, for each combination of factored loads used, the design strength in all sections must meet $\emptyset Sn \geq U$ including a) to d). the interaction between the effects of the load must be taken into account.

$$\text{a)} \quad \phi M_n \geq M_u$$

$$\text{b)} \quad \phi V_n \geq V_u$$

$$\text{c)} \quad \phi T_n \geq T_u$$

$$\text{d)} \quad \phi P_n \geq P_u$$

ϕ must be determined in accordance with Article 21.2 of SNI 2847: 2019 concerning Reduction Factors.

RESEARCH METHODS

The implementation of this research starts from April 2019 to June 2019, with the research location being carried out at Sekolah Islam Terpadu (SIT) Aliya Bogor, which is located on Jalan Gardu Raya, RT 03 / RW 11, Bubulak, West Bogor District, Bogor City, West Java 16115.
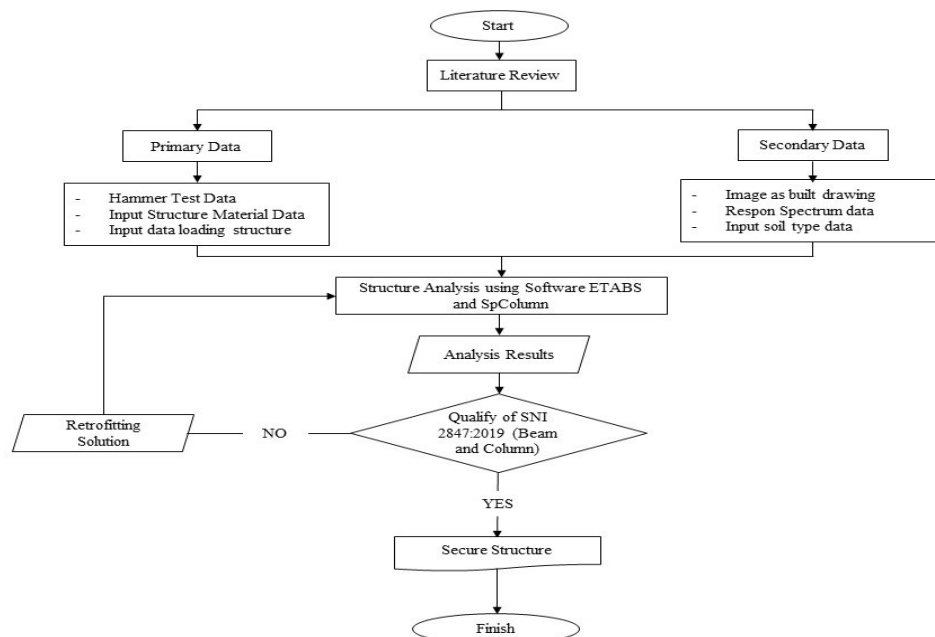

Figure 1. Stages of Evaluation Analysis of Concrete Structure System Source: Personal Documentation

The stages of the research carried out were literature studies and literature reviews, namely the study or the first step in conducting research, references commonly used in books, theses, journals, and research related to research titles (Muhamad Lutfi, Erwin Rusandi, 2019). Furthermore, data collection is divided into two, namely primary data and secondary data. Primary data is in the form of hammer test results, from the test results the existing data is processed so that the concrete quality value is obtained. Secondary data is in the form of data as built drawing, which is a technical drawing of a work report that is processed from a shop drawing according to the condition of the building that has been worked on. Next, perform a structural analysis using the ETABS V9.0.7 application, draw a construction using the Autocad 2017 application, and analyze the column structure using the SpColumn application. Planning and structural modeling based on the standardization of SNI 2857: 2019, as well as PPIUG-1983 (Muhamad Lutfi, Subtoni, 2017).

Strong concrete will make the building structure stronger, including if the road building structure will be stronger. So that the calculation results that support the building structure and road structure will again affect the conditions that will get the maximum shape. the form that will affect the concrete structure is compressive strength including building construction and road construction (S. Syaiful, L. Lasmana, 2020); (M. Marahyudi, 2020); (S. Syaiful, 2020).

RESULTS AND DISCUSSION

SIT Aliya Bogor buildings analyzed are the Umar Bin Khatab A Building and the Umar Bin Khatab B Building which have 3 floors each, the building functions as an Elementary School classroom on the 2nd and 3rd floor. In the Umar Bin Khatab A Building, the 1st floor functions as an office or teacher's room while the Umar Bin kHatab B Building on the 1st floor functions as a prayer room. The function of the building is as a school building. The building length of the Umar Bin Khatab A building is 18.60 meters; the Umar Bin Khatab B building is 23.65 meters. The width of the Umar Bin kHatab A building is 9.7 meters; the Umar Bin Khatab B building is 12.2 meters. Total 3 floors in each building. The elevation of each building is approximately 10.5 meters. The plate thickness is 12 cm. The columns used in the Umar Bin kHatab A Building are 25x25 cm; the Umar Bin Khatab B Building is 25x25 cm and 40x40 cm. The beams used in the Umar Bin Khatab A Building and the Umar Bin Khatab B Building are 20x40 cm. The building area of the Umar Bin Khatab A Building is 541.26 m^2; the Umar Bin Khatab B Building is 865.59 m^2.
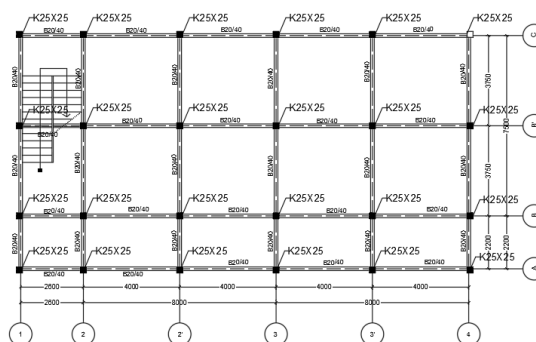
Structure Analysis

Figure 2. Column and Beam Plan in Umar Bin Khatab Building A Source: Personal Documentation
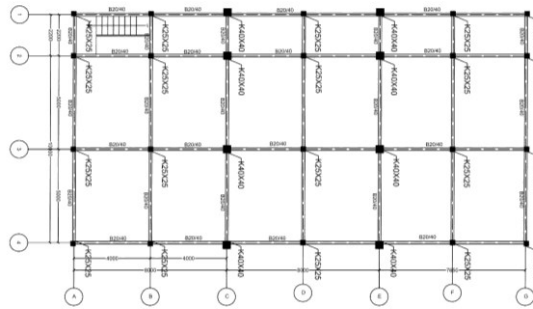
Figure 3. Column and Beam Plan in Umar Bin Khatab Building B Source: Personal Documentation
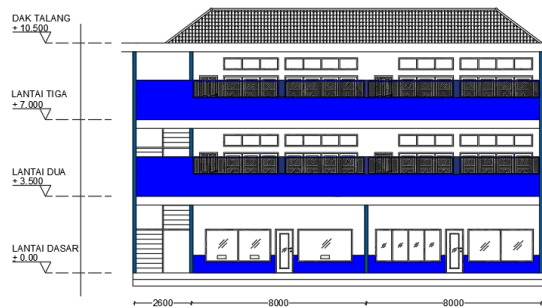

Figure 4. Front View of Umar Bin Khattab Building A Source: Personal Documentation

Figure 5. Front View of Umar Bin Khattab Building B Source: Personal Documentation

Examination of the quality of the concrete obtained from the hammer test is that the fc' column element is 23.74 Mpa, the fc beam element is 26.59 Mpa, the fc plate element is 26.59 Mpa. Based on the data input dimensions and planned material characteristics. Dead load on floor 1 and floor 2, ceramic weight 24 kg/m^2, weight ME 25 kg/m^2, ceiling weight kg/m^2, weight 11 kg/m^2 hanger. Dead load on the 3rd floor, plaster 53 kg/m^2, water proofing 5 kg/m^2, ME weight 25 kg/m^2, ceiling weight 18 kg/m^2, hanger weight 11 kg/m^2. The live load on the 1st and 2nd floors is 250 kg/m^2. The live load on the 3rd floor is 100 kg/m^2. Typical floor with slab thickness 120 mm, even load 750 kg/m'. Floor diaphragms for school buildings use a live load reduction factor of 0.80 based on PPIURG 1987. Earthquake load refers to the procedures for earthquake resistance planning for building and non-building structures Article 4.1.1 SNI 1726: 2019.
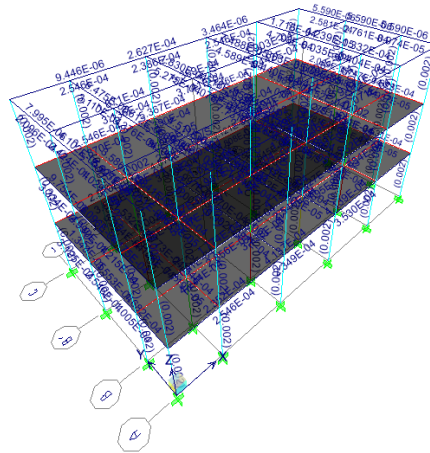
Figure 6. Results of the Existing Structure Analysis of Umar Bin Khatab Building A Source:
ETABS V.9.0.7
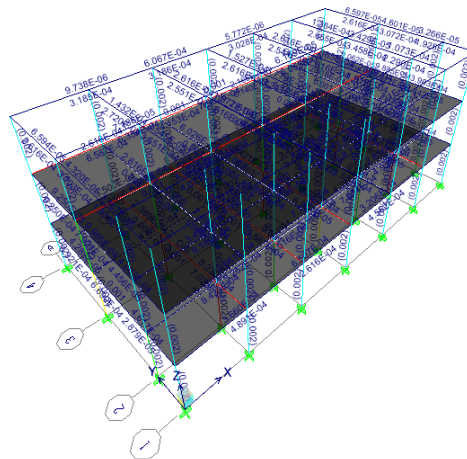
Figure 7. Results of the Existing Structure Analysis of Umar Bin Khatab Building B Source:
ETABS V.9.0.7

The results of column and beam reinforcement with a predetermined load combination can be seen in Picture 6 and Picture 7. It can be seen that all column and beam elements experiencing Over Strength (O/S) are marked in red on the elements. This means that the existing structure is not safe.

Table 4. Maximum Load and Moment Calculation

MaxAxial					
Maximum AxialForce	=	3.10	kg	=	0.03	kN
My	=	0.01	kg.m	=	0.00	kN.m
Mz	=	5195.51	kg.m	=	50.95	kN.m
M	=	5195.51	kg.m	=	50.95	kN.m

Max Moment

Axial Force	=	3.10	kg	=	0.03	kN
Maximum Mz	=	-7475.24	kg.m	=	73.31	kN.m
My	=	0.00	kg.m	=	0.00	kN.m
Axial Force	=	0.00	kg.m	=	0.00	kN.m
Mz	=	-3109.45	kg.m	=	30.49	kN.m
Maximum My	=	0.05	kg.m	=	0.00	kN.m

Source: Analysis Results of *Ms. Excel*

Based on Table 4, which is the result of column enlargement calculations, the data is used to find the value of the column interaction diagram using the SpColumn software. The results of calculations with the help of the SpColumn software are seen in Figure 11, where the results of the column interaction diagram show the existing K25x25 column with the main reinforcement D10 and the shear reinforcement Ø10-150 required an enlargement of the cross section.
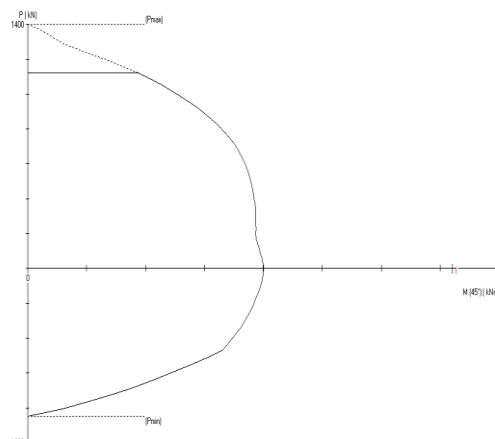
Figure 8. Calculation results with of SpColumn Source: Analysis Results of *software SpColumn*
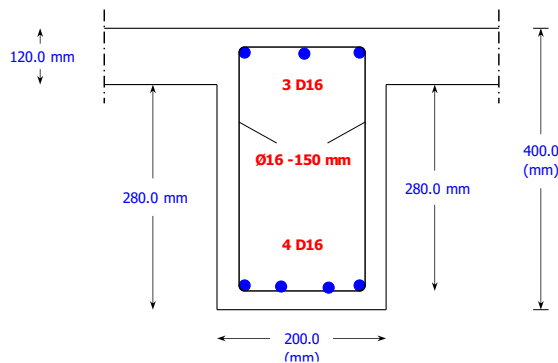
Figure 9. Results of existing 20x40 beam reinforcement Source: Personal Documentation

The solution given for strengthening the structure of columns and beams by enlarging the cross-sections was analyzed with ETABS V.0.9 and SpColumn software and then calculated with Ms. Excel.

Figure 10. Result of Building A Structure Analysis After Enlarged Section Source: ETABS V.0.9

Figure 11. Result of Building B Structure Analysis After Enlarged Section Source: ETABS V.0.9

Figure 12. Column Interaction Diagram After Enlarged Sections Source: *SpColumn*

Figure 13. Results of 35x55 Beam Reinforcement After Enlarged Cross-section Source: Personal Documentation

Table 5. Maximum Load and Moment Calculations After Enlarged Sections

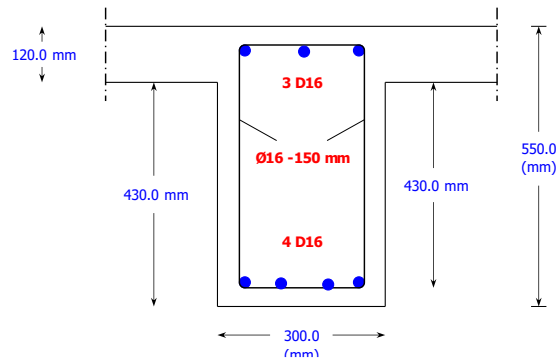| **MaxAxial**					
Maximum AxialForce	=	3.50	kg	=	0.03 kN
My	=	0.01	kg.m	=	0.00 kN.m
Mz	=	846.61	kg.m	=	8.30 kN.m
M	=	846.61	kg.m	=	8.30 kN.m
Max Moment					
Axial Force	=	2.90	kg	=	0.03 kN
Maximum Mz	=	-2917.20	kg.m	=	28.61 kN.m
My	=	0.04	kg.m	=	0.00 kN.m
Axial Force	=	0.00	kg.m	=	0.00 kN.m
Mz	=	1879.81	kg.m	=	18.44 kN.m
Maximum My	=	0.05	kg.m	=	0.00 kN.m

Source: Analysis Results of *Ms. Excel*

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Evaluation Of Sekolah Islam Terpadu (SIT) Aliya Bogor Building Structure System Based On The Requirements Of SNI 2847:2019

BUDGET PLAN FOR THE BUILDING COSTS OF THE UMAR BIN KHATAB A

BEAM AND COLUMN STRUCTURE REINFORCEMENT WORK

PROJECT   :   SIT Aliya Bogor

NO	JOB DESCRIPTION	UNIT	VOLUME	UNIT PRICE PRICE (IDR)	MATERIAL (IDR	AMOUNT
a	b	c	d	e	f	= d x (e + f)
1	Existing beam demolition work					
	- Demolition beam L - 10.6 m @ 6 be	ls	1.00	600,000.00		600,000.00
	- Demolition beam L - 9,8m @ 6 bean	ls	1.00	600,000.00		600,000.00
					Sub Total	1,200,000.00
2	Reinforcing Work					
	- Iron D-16	kg	1,137.60	2,300.00	7,700.00	11,376,000.00
	- Iron dia - 10	kg	740.00	2,300.00	7,700.00	7,400,000.00
	- Chemical angkur hilty	tube	6.00		345,000.00	2,070,000.00
					Sub Total	20,846,000.00
3	Formwork Work	m2	169.68	35,000.00		5,938,800.00
	- Plywood 9 mm	sheet	66.00		124,000.00	8,184,000.00
	- Wood 4 x 6	stem	156.00		28,000.00	4,368,000.00
	- Nail 7 cm	kg	43.00		17,000.00	731,000.00
					Sub Total	19,221,800.00
4	Casting Work	m3	10.30	600,000.00		6,177,600.00
	- Instant Cement K250 ex.Drymix	zak	456.00		53,000.00	24,168,000.00
					Sub Total	30,345,600.00
5	Finishing Work					
	- Compound	m2	169.68	10,000.00	5,000.00	2,545,200.00
					Sub Total	2,545,200.00
	GRAND TOTAL					74,158,600.00

BUDGET PLAN FOR THE BUILDING COSTS OF THE UMAR BIN KHATAB B

BEAM AND COLUMN STRUCTURE REINFORCEMENT WORK

PROJECT   :   SIT Aliya Bogor

NO	JOB DESCRIPTION	UNIT	VOLUME	UNIT PRICE PRICE (IDR)	MATERIAL (IDR	AMOUNT
a	b	c	d	e	f	= d x (e + f)
1	Existing beam demolition work					
	- Demolition beam L - 23,65 m @ 2 b	ls	1.00	200,000.00		200,000.00
	- Demolition beam L - 10,2m @ 7 bea	ls	1.00	700,000.00		700,000.00
					Sub Total	900,000.00
2	Reinforcing Work					
	- Iron D-16	kg	1,042.80	2,300.00	7,700.00	10,428,000.00
	- Iron dia - 10	kg	680.80	2,300.00	7,700.00	6,808,000.00
	- Chemical angkur hilty	tube	6.00		345,000.00	2,070,000.00
					Sub Total	19,306,000.00
3	Formwork Work	m2	166.04	35,000.00		5,811,400.00
	- Plywood 9 mm	sheet	59.00		124,000.00	7,316,000.00
	- Wood 4 x 6	stem	140.00		28,000.00	3,920,000.00
	- Nail 7 cm	kg	72.00		17,000.00	1,224,000.00
					Sub Total	18,271,400.00
4	Casting Work	m3	10.30	600,000.00		6,177,600.00
	- Instant Cement K250 ex.Drymix	zak	263.00		53,000.00	13,939,000.00
					Sub Total	20,116,600.00
5	Finishing Work					
	- Compound	m2	166.04	10,000.00	5,000.00	2,490,600.00
					Sub Total	2,490,600.00
	GRAND TOTAL					61,084,600.00

CONCLUSION

Based on the results of the analysis and discussion that has been carried out, it can be concluded that the existing column structure of Umar Bin Khatab A Building and Umar Bin Khatab B Building which coincided with SIT Aliya Bogor experienced Over Strength in several columns and beams. In the Umar Bin Khatab A Building, the column dimensions become K40x40 with shear reinforcement Ø39-150 mm, the beam dimensions are enlarged to 30x55. In the Umar Bin Khatab B Building, the column dimensions with dimensions of K25x25 are enlarged to K40x40 with shear reinforcement Ø25-150, the dimensions of the beams with dimensions of 20x40 are enlarged to become 30x55 beams. The budget for strengthening the beam structure in the Umar Bin Khatab A Building is Rp 74,158,600.00 and in the Umar Bin Khatab B Building Rp 61,084,600.00.

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