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ANALYSIS AND DESIGN STRUCTURE OF BUILDING OFFICE AND ADMINISTRATIVE AL-BAHJAH CIREBON

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ABSTRACT

Al-Bahjah is a formal and non-formal educational institution that combines general education with Al-Quran which is located on Pangeran Cakrabuana Street, Sumber, Cirebon District. The construction of Building Office and Administration Al-Bahjah is indispensable as a center for management and administration.

The planning of the Building Office and Administrative Al-Bahjah has a floor size of 30 m x 14 m with 5 floors of structure and building height of 19.60 m. The building structure is designed with reference to SNI 1727 - 2013, PPIUG 1987, SNI 2847 - 2013 and SNI 1726 - 2012. The static equivalent analysis method is used in analyzing earthquakes. The structure lies in the class of medium land sites (SD) and is included in the type D Seismic Design Category, so the earthquake force on the structure is planned using a configuration of the structure of the Special Moment Resisting Frame (SMRF). ETABS v9.6 structure analysis program is used to help structure modeling and calculate internal forces acting on the structure, with the material used is concrete f'c 25 Mpa, reinforcement fy 400 Mpa and fy 240 Mpa.

Keyword: *SNI 1727-2013, PPIUG 1987, SNI 2847-2013, SNI 1726-2013, Seismic Design Category D, Lateral Equivalent Analysis, SMRF, ETABS v9.6.0*

I. PRELIMINARY

A. BACKGROUND

Al-Bahjah is a formal and non-formal educational institution that combines general education with Al-Quran which is located on Pangeran Cakrabuana Street, Sumber, Cirebon District. With an area of campus about 2.5 hectares *(Muh. Abdus Syakur* /Hidayatullah.com), inside must be used efficiently for various infrastructure facilities to support campus activities, given the growing LPD Al-Bahjah will attract many enthusiasts either students or entrants will be studying. The development of "Building Offices and Administrative Al Bahjah" is one of the buildings planned for efficiency use of available land in order to be optimal, as the center of management and administrative. Therefore, building design must meet the safety and service excellence for it to be no convincing design in accordance with the regulations of the Indonesian National Standard.

B. FOCUS PROBLEM

In this research focused on Designing and Analyzing of Building Offices and Administrative Al-Bahjah - Cirebon with reinforced concrete structures, which include beam, column, slab, foundation and seismic force that react to the structure of building which refers to regulations SNI 2847-2013 about structural concrete requirements for buildings, PPIURG 1987 and SNI 1727 – 2013 about the minimum load for the planning of buildings and SNI 1726-2012 about seismic force.

C. PROBLEM FORMULATION

1) How to design and analyze structure Offices and Administrative Building of Al-Bahjah - Cirebon using a reinforced concrete structure according the regulations of SNI ?
2) How to design and analyze dimension of the slab, beams, columns, and foundations ?
3) How seismic force that occur in the structure Offices and Administrative Building of Al-Bahjah – Cirebon ?
4) How to calculate the budget structure Offices and Administrative Building of Al-Bahjah – Cirebon ?

D. BOUNDARIES OF PROBLEM

In order to avoid widening of problem discussion, the limitation in forming this thesis given as follows :

a) Just design and analyze the main structure:
   - Tie Beam / Sloof
   - Beam
   - Column
   - Slab
   - Pile Cap & Bored Pile Foundation
b) For earthquake analiysis procedure, just calculating the static lateral equivalent.
c) Does not design and analyze the support structure :
   - Shear Wall
   - Stairs
   - Mechanical Electrical , Plumbing
d) Visualizing through 2D and 3D drawing.
e) Analysis structure with ETABS
f) Calculating the budget of the structure only.

E. RESEARCH OBJECTIVES

a) Can design and analyze Offices and Administrative Building of Al-Bahjah - Cirebon based on regulations SNI 2847-2013, SNI 1727-2013, PPIURG 1987 and SNI 1726-2012.
b) Can analyze and design of slab, beam, column, and foundation.
c) Can analyze the seismic forces that occur in the building structure.
d) Can estimating the Budget Plan (RAB) Building Structure.

F. USEFULNESS OF RESEARCH

1. The theoretical usefulness
2. The practical usefulness

II. REVIEW OF THE LITERATURE AND THE THEORETICAL BASIS

A. RESEARCH THAT HAS BEEN DONE BEFORE

1. First, research conducted by Yusuf (2015) with the title **Analisis Perencanaan Gedung Aula dan Rektorat Universitas Swadaya Gunung Jati Cirebon dengan Struktur Beton**.
2. Second, Research conducted by Aries Saputra (2017) with the title **Analisis Perencanaan Struktur Rumah Sakit Permata Cirebon.**
3. Third, research conducted by Arrozaq (2018) with the title **Perencanaan Pembangunan Puskesmas Pabuaran Kabupaten Cirebon.**

B. THEORRETICAL BASIS

1. Definition of Building

Building is a physical form of the result a construction work that integrates with its domicile, part or all of it is above and / or in the land and / or water, which functions as a place for humans to carry out our their activities, whether for residence , religious activities, business activities, social activities, cultural and special activities. *(Undang-Undang Republik Indonesia No. 28 tahun 2002 Pasal 1 Ayat 1 tentang Bangunan Gedung)*.

2. Definition of Reinforced Concrete

Reinforced concrete is reinforced concrete with an area and the amount of reinforcement that is not less than the minimum required value with or without prestressing, and planned based on the assumption that the two materials work are together in carrying forces. Reinforced concrete is made from a combination of concrete and steel reinforcement. Therefore, it has the same properties as the constituent materials are very strong against compressive load and tensile load. (SNI 03-2847-2002 Pasal 3)

3. Planning Basic

a. Service Ability */Kemampuan Layan*

Structure and components must be designed to have strength of design in all sections of at least the required strength calculated for loads and factored forces in such a combination as specified in the standard. (SNI 2847-2013)

b. *Kuat Perlu (U)*

Kekuatan perlu (U) must be at least equal to the effect of deep factored load (combination load used). The combination load there are:

1) *Combo 1* $= (1{,}4_{SW} + 1{,}4_{DL})$
2) *Combo 2* $= (1{,}2_{SW} + 1{,}2_{DL}) + 1{,}6_{LL}$
3) *Combo 3* $= (1{,}2_{SW} + 1{,}2_{DL}) + 1{,}0_{Eqx} + 1{,}0_{LL}$
4) *Combo 4* $= (1{,}2_{SW} + 1{,}2_{DL}) + 1{,}0_{Eqy} + 1{,}0_{LL}$
5) *Combo 5* $= (1{,}2_{SW} + 1{,}2_{DL}) + 1{,}0_{Wx} + 1{,}0_{LL}$
6) *Combo 6* $= (1{,}2_{SW} + 1{,}2_{DL}) + 1{,}0_{Wy} + 1{,}0_{LL}$
7) *Combo 7* $= (0{,}9_{SW} + 0{,}9_{DL}) + 1{,}0_{Eqx}$
8) *Combo 8* $= (0{,}9_{SW} + 0{,}9_{DL}) + 1{,}0_{Eqy}$
9) *Combo 9* $= (0{,}9_{SW} + 0{,}9_{DL}) + 1{,}0_{Wx}$
10) *Combo 10* $= (0{,}9_{SW} + 0{,}9_{DL}) + 1{,}0_{Wy}$

c. Strength of Design */Kuat Desain*

Stength of design provided by a structural component, connection with other structural components, and its cross section, with bending, normal force, and torsi must be taken in the amount of nominal strength calculated according to the requirements and assumptions of SNI 2847-2013.

1) *Penampang terkendali tarik* $\phi = 0{,}90$
2) *Penampang terkendali tekan*
   (a) *Dengan tulangan spiral* $\phi = 0{,}75$
   (b) *Komponen struktur lain* $\phi = 0{,}65$
3) *Geser dan Torsi* $\phi = 0{,}75$
4) *Tumpuan pada beton* $\phi = 0{,}65$

4. Loading

Expenses It is the force or other action derived from the weight of all building materials, occupants, items in the building, environmental effects, displacement differences, and restraints due to dimensional changes. *(SNI 1727-2013).*

a. Vertical Load

1) Dead Load

The dead load is the weight of all building construction materials installed, including walls, floors, roofs, ceilings, stairs, partition walls remain, finishing, buildings kladding and other structural and architectural components as well as other connected equipment including heavy serviceability tap. *(SNI 1727:2013 pasal 3.1.1)*

Table 2.1 Building materials PPIUG 1987

No.	Material	Berat	Keterangan
1.	Baja	7850 kg/m³	
2.	Batu alam	2600 kg/m³	
3.	Batu belah, batu bulat, batu gunung	1500 kg/m³	berat tumpuk
4.	Batu karang	700 kg/m³	berat tumpuk
5.	Batu pecah	1450 kg/m³	
6.	Besi tuang	7250 kg/m³	
7.	Beton	2200 kg/m³	
8.	Beton bertulang	2400 kg/m³	
9.	Kayu	1000 kg/m³	kelas I
10.	Kerikil, koral	1650 kg/m³	kering udara sampai lembab, tanpa diayak
11.	Pasangan bata merah	1700 kg/m³	
12.	Pasangan batu belah, batu bulat, batu gunung	2200 kg/m³	
13.	Pasangan batu cetak	2200 kg/m³	
14.	Pasangan batu karang	1450 kg/m³	
15.	Pasir	1600 kg/m³	kering udara sampai lembab
16.	Pasir	1800 kg/m³	jenuh air
17.	Pasir kerikil, koral	1850 kg/m³	kering udara sampai lembab
18.	Tanah, lempung dan lanau	1700 kg/m³	kering udara sampai lembab
19.	Tanah, lempung dan lanau	2000 kg/m³	basah
20.	Timah hitam / timbel)	11400 kg/m³	

2) Live Load

Life load is the load caused by the users and occupants of buildings or other structures

Table 2.2 Live Load SNI 1727-2013

Hunian atau penggunaan	Merata psf (kN/m²)	Terpusat lb (kN)
Apartemen (lihat rumah tinggal)		
Sistem lantai akses Ruang kantor Ruang komputer	50 (2,4) 100 (4,79)	2 000 (8,9) 2 000 (8,9)
Gudang persenjataan dan ruang latihan	150 (7,18)[a]	
Ruang pertemuan Kursi tetap (terikat di lantai) Lobi Kursi dapat dipindahkan Panggung pertemuan Lantai podium	100 (4,79)[a] 100 (4,79)[a] 100 (4,79)[a] 100 (4,79)[a] 150 (7,18)[a]	
Gedung perkantoran: Ruang arsip dan komputer harus dirancang untuk beban yang lebih berat berdasarkan pada perkiraan hunian Lobi dan koridor lantai pertama Kantor Koridor di atas lantai pertama	100 (4,79) 50 (2,40) 80 (3,83)	2 000 (8,90) 2 000 (8,90) 2 000 (8,90)
Lembaga hukum Blok sel Koridor	40 (1,92) 100 (4,79)	
Tempat rekreasi Tempat bowling, Kolam renang, dan penggunaan yang sama Bangsal dansa dan Ruang dansa Gimnasium Tempat menonton baksterbuka atau tertutup Stadium dan tribunlarena dengan tempat duduk tetap (terikat pada lantai)	75 (3,59)[a] 100 (4,79)[a] 100 (4,79)[a] 100 (4,79)[a,e] 60 (2,87)[a,e]	
Rumah tinggal Hunian (satu keluarga dan dua keluarga) Loteng yang tidak dapat didiami tanpa gudang Loteng yang tidak dapat didiami dengan gudang Loteng yang dapat didiami dan ruang tidur Semua ruang kecuali tangga dan balkon Semua hunian rumah tinggal lainnya Ruang pribadi dan koridor yang melayani mereka Ruang publik[a] dan koridor yang melayani mereka	10 (0,48)[f] 20 (0,98)[f] 30 (1,44) 40 (1,92) 40 (1,92) 100 (4,79)	

b. Horizontal Load

1) Earthquake Load

Earthquake load is the load arising from the movement of the ground where the structure is standing. Because the building structure has mass, the mass inertia from the top of the building provides resistance to movements. Therefore the earthquake load is very dependents on the mass of a building, and the movement of the earthquake to reach the surface of the land is affected by local soil conditions.

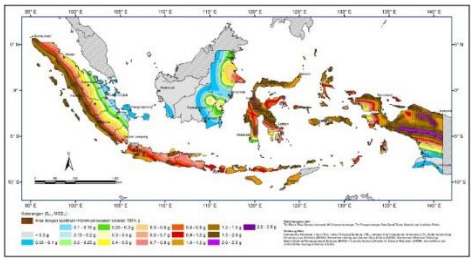


Figure 2.1 Peta gerak tanah seismik dan koefisien resiko

- Site class = Categories SD (medium)
- Earthquake acceleration parameter (Ss,S1) for the location of Al-Bahjah Sendang, Sumber - Cirebon with latitude *-6,755881204105325* and *longitude 108,5034334695764* is Ss = 0,733 g and S1 = 0,296 g
- Earthquake acceleration response parameter S_{MS} = 0,889 and S_{M1} = 0,535
- Seismic design category
  S_{DS} = 0,593 ≥ 0,50 (Category D, high seismic risk level)
- Structur system, the type of building structure that was reviewed used Special Moment Resisting Frame (SMRF)
- Earthquake analysis procedure used lateral equivalent analysis.

Table 2.3 Seismic effective weight the structure

Group	Additional Dead Load (kN)	Reduction 25 % Live load (kN)	Self weight	Seismic Weight (W)
1st Floor	1764,4	252	2921,24	4937,64
2nd Floor	1444,4	377,475	2894,735	4716,61
3rd Floor	1575,2	262,5	2947,745	4785,445
4th Floor	1765,2	262,5	2925,045	4952,745
Roof	399	100,8	2588,131	3087,931
			14276,896	22480,371

2) Wind Load

Wind load acting on a building depends on the average speed of the wind at the location of the building. The wind load input using reference ASCE 07 (Pasal 6. SNI 1727-2013)

- Wind velocity (mph)
  Average wind velocity in the area building at Sendang – Sumber, Cirebon.
  V = 8,6992 mph (meteo.bmkg.co.id)
- Wind direction factor
  Kd= 0,85 (pasal 26.6 SNI 1727-2013)
- Exsposure type = Category B

- Topographic factor
  Kzt = 1.00 (pasal 26.8.1 SNI 1727-2013)

5. Basic Calculations

a. Slab

Slab are horizontal elements structure that support dead loads and live loads and distribute them to the vertical frame in a structural system. Slab designed are two way system. Slab calculation uses the following formula:

- Dimension (thickness) of slab
  $\frac{\ln(0,8+\frac{fy}{1400})}{36+5\beta(\alpha\, fm-0,2)}$ for (0.2 <αfm <2.0)
- Momen of slab (PBI 1971)
  $Mlx^{(+)}$ = 0,001 . Qu . lx^2 . Clx
  $Mly^{(+)}$ = 0,001 . Qu . lx^2 . Cly
  $Mtx^{(-)}$ = - 0,001 . Qu . lx^2 . Ctx
  $Mty^{(-)}$ = - 0,001 . Qu . lx^2 . Cty
- Requirements
  Ø Mn ≥ Mu, with Ø = 0,85

b. Beam

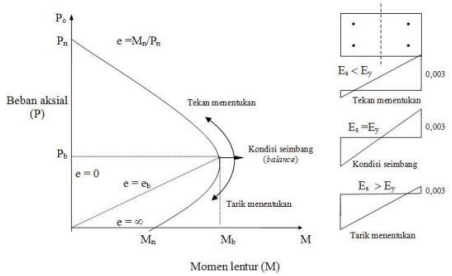
Beams are structural members that support the vertical and horizontal loads. *(Kenneth-Belanger, 1981*). The elements acting on the beam are usually a flexural load, a shear load, and a torsion load, so that reinforcing steel is required to withstand the load. Beam calculation uses the following formula:

- Dimension
  h_{min} = $\frac{L}{16}$ x (0,4 + $\frac{fy}{700}$)
  b_{min} = ½ h s/d ⅔ h
- Load Ultimate
  Q_u = 1,2 $_{DL}$ + 1,6 $_{LL}$
- Moment Ultimate
  (Tabel momen primer-croos / soemono)
- Longitudinal rebar
  $\rho = \frac{0,8fy-\sqrt{(0,8fy)^2-4\,x\left(0,4704\,x\,\frac{fy^2}{fc}\right)x\left(\frac{Mu}{bd^2}\right)}}{2\,x\left(0,4704\,x\,\frac{fy^2}{fc}\right)}$
  As (rebar area) = ρ x b x d'
- Shear rebar
  Vc = $\phi\left(\frac{1}{6}\sqrt{fc'}\right)$ x b x d' , with Ø = 0,75
- Requirements
  Ø Mn ≥ Mu, with Ø = 0,90

c. Column

Column is the vertical rod of the frame structure that carries the load from the roof, beam, and its own weight which is forwarded to the foundation. Column calculation uses the following formula:

- Load Ultimate
  Pu = 1,2 $_{DL}$ + 1,6 $_{LL}$
- Moment Ultimate
  Mu = 1,2 M_{DL} + 1,6M_{LL}
- Eccentricity value (e)
  e = $\frac{Mu}{Pu}$
- Longitudinal rebar
  $\frac{Pu}{\emptyset\, x\, Agr\, x\, 0,81fc}\, x\, \frac{et}{h}$
  ρ = β x r ; As_{min} = ρ x A_{gr}
  ρ (grafik interaksi kolom)
- Shear rebar
  Vc = $\phi\left(\frac{1}{6}\sqrt{fc'}\right)$ x b x d' , with Ø = 0,75
- Requirements
  $\boldsymbol{P_{n\,(max)}} = 0,85\Phi\left[0.85f_c'\left(A_g - A_{st}\right) + f_y A_{st}\right]$
  Ø $P_n \geq P_u$, with Ø = 0,65
- Column Interaction



Picture 2.2 Diagram interaksi kolom

d. Principle of SMRF/ SPRMK

1) Beam
   - Dimension must comply the requirements. Pasal 21.5.1 , Pasal 21.5.1.2 , Pasal 21.5.1.3
   - Logitudinal reinforcement. Pasal 12.5.2
   - Shear reinorcement. Pasal 21.5.3.2 , Pasal 21.5.3.3 , Pasal 21.5.3.4

2) Column
   - Dimensions. Pasal 21.6.1 , Pasal 21.6.1.1 , Pasal 21.6.1.2
   - Longitudinal reinforcement. Pasal 21.6.3.1
   - Shear reinforcement. Pasal 21.6.4.3
   - Convinement reinforcement. Pasal 21.6.4.4

e. Foundation (Bored Pile)

Bore pile foundation is a tube-shaped deep foundation, which functions to continue the load on the building structure above it from the ground surface to the hard soil layer below it.

- Daya Dukung Pondasi
  $Q_u = Q_d + Q_g - W$
  $Q_{ijin} = Q_u / SF$
- Daya dukung ujung tiang
  $Q_d = 750 * Ap$ (untuk N-SPT > 50)
- Daya dukung gesekan tiang
  $Q_g = O * (Ni/2 * Li)$ (untuk N-SPT > 50)
- Effisiensi tiang group
  Rumus Converse Labarre
  $$\eta = 1 - \frac{\emptyset}{90} \times \left[\frac{(n-1)m+(m-1)n}{(m \times n)}\right]$$
- Requirements
  $Pu < P_{effisiensi}$

III. METHOD AND OBJECT OF RESEARCH

A. METHOD OF RESEARCH

1. The Research Methods Used

The research method used is a method of quantitative and qualitative methods, understanding as below:

a) Quantitative method is a method performed by learning the references and study literature for the preparation of the thesis. There are the research method used :
   - SNI – 2847 – 2013 (*Persyaratan beton struktural untuk bangunan gedung*)
   - SNI – 1726 – 2012 (*Tata cara perencanaan ketahanan gempa untuk struktur bangunan gedung dan Non-gedung*)
   - SNI – 1727 – 2013 (*Beban minimum untuk perancangan bangunan gedung dan struktur lain*)
   - PPPURG 1987 (*Pedoman Perencanaan Pembebanan Untuk Rumah dan Gedung*)

b) Qualitative method is a method performed by collecting field data that will be used as the data in the project. There are :
   - SPT data
   - Building Area
   - Function of building

2. The Types and Sources of Data

The data source is something that can provide information about the data. By type, data can be divided into two, namely primary data and secondary data.

a) Primary data is data created by researchers for the special purpose resolve problems that are being addressed.
b) Secondary data is data that has been collected for purpose other than resolve the problems being faced.

3. Technique of Data Collection

In the preparation of this thesis, the collection of data obtained by the authors carried out in a manner as follows:

a) Observation or direct observation to the field to observe directly the object of the research.
b) Interviews with contractors and consultants in the project.
c) Explore and examine theories or methods in the library.

4. Metode Analisis Data

Stage of analysis using ETABS v9 and analysis manually as a comparison. The stages of analysis used in this paper are as follows

a) Structure modeling
b) Design element structure
c) Calculate the loads
d) Calculate the dimensions and strength of the structure
e) Calculate the earthquake force

B. LOCATION OF RESEARCH

The location of the research reviewed by the authors in this thesis is located at Pangeran Cakrabuana Street No. 179, Sendang Village, Sumber Sub-distric, Distric of Cirebon.

C. FLOW OF RESEARCH

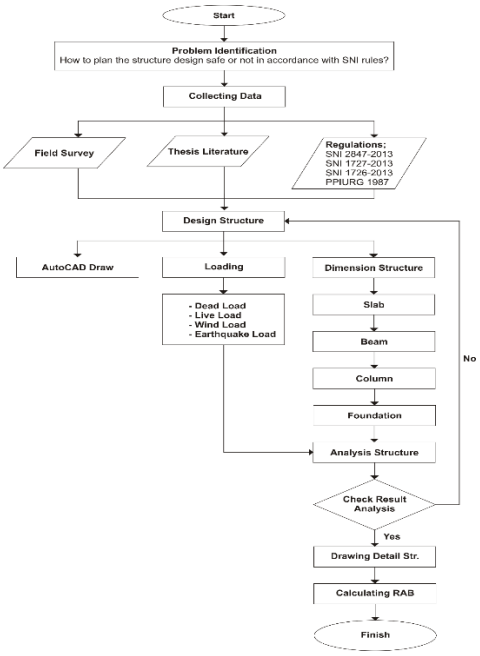


Figure 3.1 Flowchart of research methodology

D. DESIGN OF BUILDING

The design of the building used software AutoCAD and Sketchup Rendering 3D.

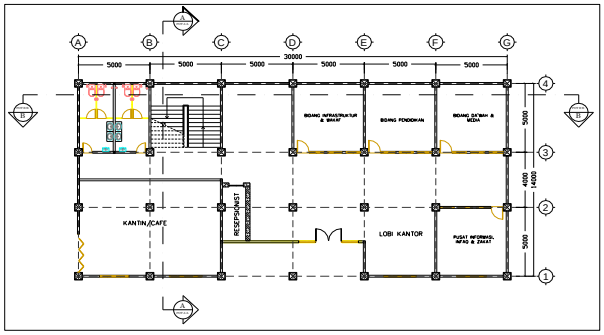


Figure 3.2 Base Elv. ± 0.00 m

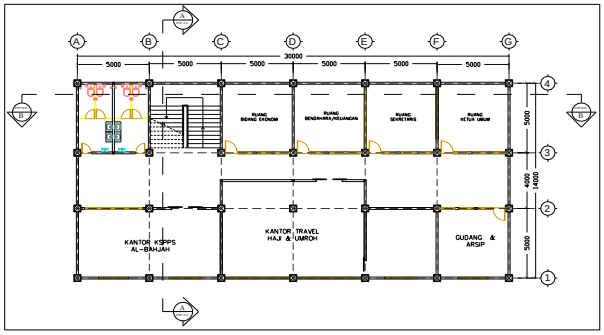


Figure 3.3 1st Floor Elv. + 4.00 m

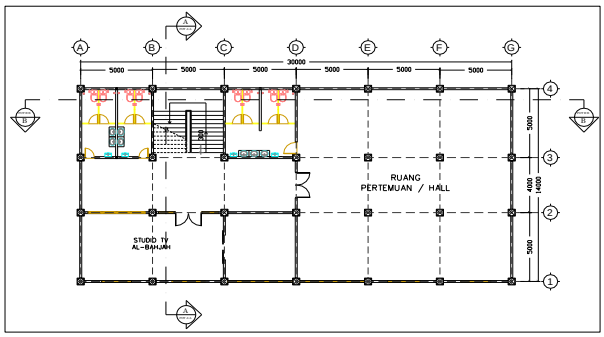


Figure 3.4 2nd Floor. + 8.00 m

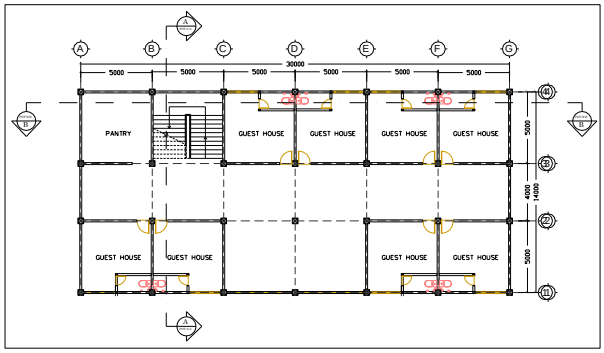


Figure 3.5 3rd Floor Elv. + 12.00 m

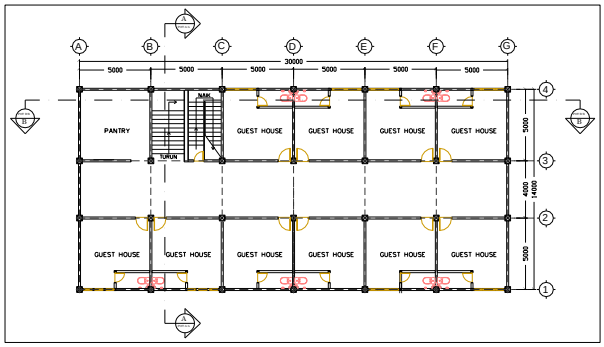


Figure 3.6 4th Floor Elv. + 15.80 m

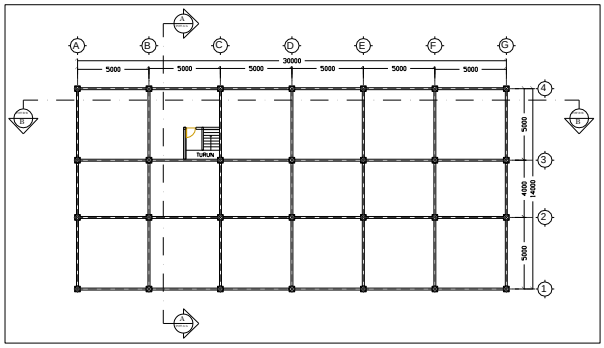


Figure 3.7 4th Floor Elv. + 19.60 m

Figure 3.8 Tampak Depan

IV. DESIGN AND ANALYSIS

A. DATA DESIGN STRUCTURE

1. Building Spesification

a) Name of Project: Development Project Building Office and Administrative of Al-Bahjah Cirebon

b) The building consist of five levels with reinforced concrete structure

c) Total building area : 2520 m^2

- Base : 420 m^2
- 1st Floor : 420 m^2
- 2nd Floor : 420 m^2
- 3rd Floor : 420 m^2
- 4th Floor : 420 m^2
- Rooftop : 420 m^2

d) Building length : 30,00 m

e) Building width : 14,00 m

f) Building height : 19,60 m

Table 4.1 Building configuration

No.	Lantai	Elevasi (m)
1.	Base Floor	± 0,00 m
2.	1st Floor	+ 4,00 m
3.	2nd Floor	+ 8,00 m
4.	3rd Floor	+ 12,00 m
5.	4th Floor	+ 15,80 m
6.	Roof floor	+ 19,60 m

2. Material Spesification

a) Concrete : fc' 25 Mpa, K 301,20 kg/cm^2

For all structure elements, there are slab, beam, column, and bored pile

b) Rebar

Longitudinal rebar : BJTD 40 (fy 400 Mpa)

Transversal rebar : BJTP 40 (fy 240 Mpa)

Table 4.2 Structure materials

No.	Type Structure	Rebar	
		Longitudinal	Transversal
1.	Slab	Ø 12	Ø 8
2.	Beam	D 16	Ø 10
3.	Column	D 22	D 10
4.	Pile Cap	D 22	D 10

3. Data Frame of Structure

Table 4.3 Structure dimensions

Type of Structure	Type / Code	Dimensions (mm)
Slab	Slab Rooftop	100
	Slab 1st – 4th	130
Beam	Sa	250/400
	S1	300/500
	Ba	250/450
	B1	300/550
	B2	300/550
	B3	300/550
	B4	300/550
	B5	300/500
	B6	300/500
Column	K1	500 x 500
	K2	550 x 550
Pile Cap	P1	2750 x 2750 x 750
Bored Pile	BP1	Ø500

B. STRUCTURE MODELING

In the analysis of this building structure using software ETABS v.9.6.0. In generally the analysis and design in ETABS was consist of modeling structure, defining material properties and frame section then determination of loading and analysis model of structure.

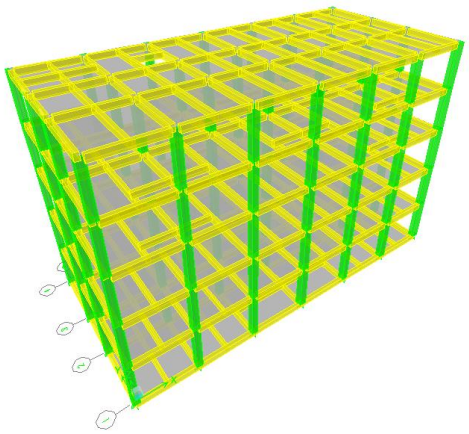


Figure 4.1 Model Structure on ETABS v.9.6.0

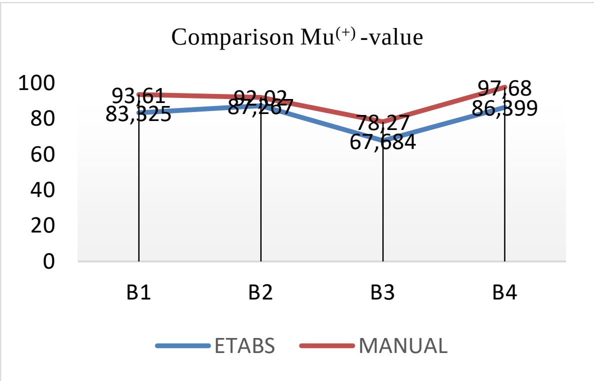
C. RESULT DESIGN & ANALYSIS STRUCTURE

1. Structure Reinforcement

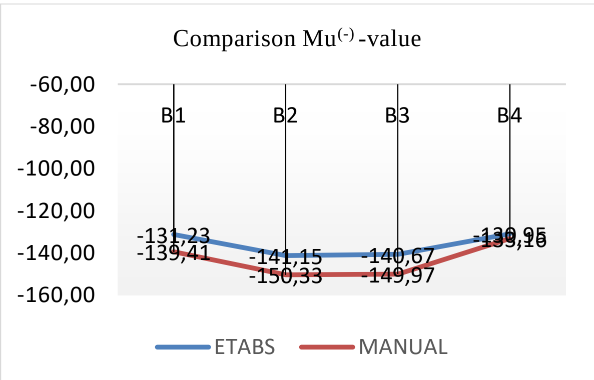
In calculating structure reinforcement (there are Beam, Column, Slab, Pile Cap, Bored Pile) used output ETABS analysis and manual analysis as comparison.

Table 4.4 Comparison force of beam in ETABS analysis with Manual analysis

Code	Label (Story)	ETABS Analysis			Manual Analysis			Validasi (%)
		M3	Vu	δ_{max}	Mu	Vu	δ	
B1	B81 (Lt. 2)	83,33	83,78	0,50	93,61	92,18	3,15	10,98
		-131,23			-139,41			5,87
B2	B40 (Lt. 2)	87,27	128,82	1,19	92,02	138,95	4,44	5,16
		-141,15			-150,33			6,11
B3	B79 (Lt. 3)	67,68	112,64	1,14	78,27	120,62	4,72	13,52
		-140,67			-149,97			6,20
B4	B64 (Lt. 3)	86,40	106,08	1,22	97,68	108,93	3,59	11,55
		-130,95			-133,16			1,66



Grafic 4.1 Chart of Mu(+) -value in ETABS analysis and Manual analysis



Grafic 4.2 Chart of Mu(-) -value in ETABS analysis and Manual analysis

Table 4.5 Recapitulation of Beam reinforcement

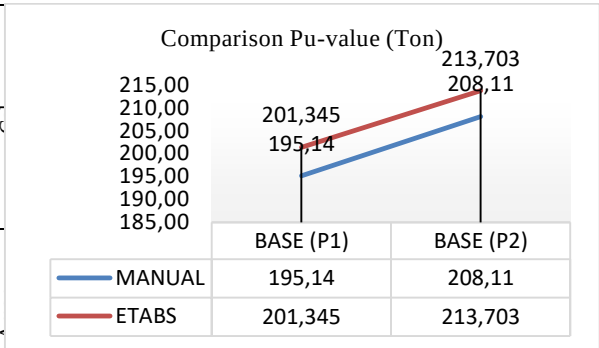
Type	Location	ETABS Analysis Longitudinal (mm^2)	ETABS Analysis Shear (mm^2)	Manual Analysis Longitudinal (mm^2)	Manual Analysis Shear (mm^2)	Applied reinforcement Longitudinal (D)	Applied reinforcement Shear (Ø)
SA (250 x 400)	Support	296	0,35	267	0,466	2 D 16	10 - 150
	Field	247		250		2 D 16	
S1 (300 x 500)	Support	563	0,92	626	0,764	4 D 16	10 - 150
	Field	610		680		4 D 16	
BA (250 x 450)	Support	294	0,35	306	0,557	2 D 16	10 - 150
	Field	205		172		2 D 16	
B1 (300 x 550)	Support	796	0,91	942	0,78	5 D 16	10 - 150
	Field	527		619		4 D 16	
B2 (300 x 550)	Support	859	1,32	1021	1,18	6 D 16	10 - 150
	Field	593		608		4 D 16	
B3 (300 x 550)	Support	856	0,97	1019	1,02	6 D 16	10 - 150
	Field	527		517		4 D 16	
B4 (300 x 550)	Support	794	0,99	897	0,92	5 D 16	10 - 150
	Field	555		647		4 D 16	
B5 (300 x 500)	Support	202	0,43	414	0,214	3 D 16	10 - 150
	Field	101		83		2 D 16	
B6 (300 x 500)	Support	388	0,571	414	0,497	3 D 16	10 - 150
	Field	377		314		2 D 16	

Table 4.6 Maximum value of Axial force (Pu) and Momen (Mu) Column

Column Type	Name Label	Combo	Gaya Aksial (Pu) kN	Momen (Mu) kNm	Type Foundation	Manual Output		ETABS Output		Validasi (%)
						Load Combination	Pu (kN)	Load Combination	FZ (kN)	
K1	C19	KOMBO2-1	-1704,72	144,615	P1	$1,2P_D + 1,6P_L$	1951,43	$1,2P_D + 1,6P_L$	2013,45	2,33
K2	C18	KOMBO2-1	-1829,57	145,769	P2	$1,2P_D + 1,6P_L$	2081,06	$1,2P_D + 1,6P_L$	2137,03	3,32

Table 4.7 Recapitulation of Column reinforcement

Column Type	$A_{s\ perlu}$	Longitudinal rebar		$A_{s\ aktual}$	Cek	$A_{vs\ perlu}$	Shear rebar		$A_{vs\ aktual}$	Cek
		n	Ø				Ø	Jarak		
K1 (500 x 500)	2500	8	22	3041	Aman	0,49	10	100	1,57	Aman
K2 (550 x 550)	3025	8	22	3041	Aman	0,64	10	100	1,57	Aman



Grafic 4.3 Chart of Point load Pu-value in output ETABS Analysis and Manual Analysis

Table 4.8 Recapitulation of Slab reinforcement

Type Pelat	Function	Reinforcement	
		X - direction (mm)	Y - direction (mm)
S1-1 (5 x 2,5m)	Office	Ø 12 - 150	Ø 12 - 150
S1-2 (4 x 2,5m)		Ø 12 - 150	Ø 12 - 150
S1-3 (2,5 x 2m)		Ø 12 - 150	Ø 12 - 150
S2-1 (5 x 2,5m)	Meeting room	Ø 12 - 150	Ø 12 - 150
S2-2 (4 x 2,5m)		Ø 12 - 150	Ø 12 - 150
S3-1 (5 x 2,5)	Guest House	Ø 12 - 150	Ø 12 - 150
S3-2 (4 x 2,5)		Ø 12 - 150	Ø 12 - 150
S3-3 (3,75 x 2,5m)		Ø 12 - 150	Ø 12 - 150
S3-4 (2,5 x 1,25m)		Ø 12 - 150	Ø 12 - 150
S4-1 (5 x 2,5m)	Rooftop	Ø 10 - 175	Ø 10 - 175
S4-2 (4 x 2,5m)		Ø 10 - 175	Ø 10 - 175

Table 4.9 Comparison of load point (output ETABS Analysis and Manual analysis)

Table 4.10 Bearing capacity bored pile with various diameters

D (m)	A_p (m2)	O (m)	W (ton)	N-SPT	Q_d (ton)	Q_g (ton)	Q_{ijin} (Ton)
0,6	0,28	0,47	6,78	50	212,05	117,81	103,17
0,5	0,19	0,39	4,71	50	147,26	98,17	77,10
0,4	0,12	0,31	3,01	50	94,24	78,54	54,58

Table 4.11 Group pile efficiency

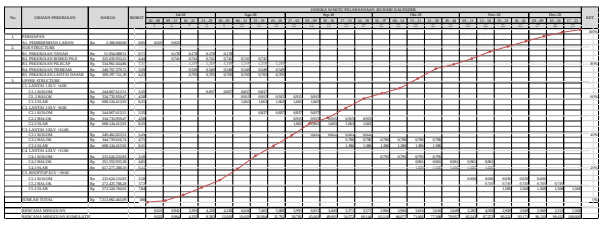
Poer	Effisiensi	N (TP)	Qall	Efisiensi 1 Tiang	Efisiensi Group	Cek
1	0,86	3	77,10	66,56	199,69	NO
2	0,80	4	77,10	61,29	245,18	YES
3	0,76	6	77,10	58,66	351,96	YES
4	0,74	8	77,10	57,34	458,74	YES

***Note:**

The value of group pile efficiency at poer 1 was tried with the number of pile as much as 4 , shown $V_{total} < V_{efisiensi}$ (213,7 < 245,18) means comply the requirements (YES)

Table 4.12 Cost plan of structure building

No. Item	Description	Unit	Estimate Quantity	Unit Price (Rp.)	Total Price (Rp.)
SECTION A	**PREPARATION**				
A1	**Site Clearing**	m^2	420,00	Rp 8.000,00	Rp 3.360.000,00
SECTION B	**FOOTING STRUCTURE**				
B1	**Drilling of soil**	m^3	**230,91**	**Rp 225.000,00**	**Rp 51.954.088,51**
B2	Bored Pile Foundation Concrete	m^3	230,91	Rp 1.407.639,65	Rp 325.033.933,22
B3	Pile Cap Concrete	m^3	166,75	Rp 1.180.497,76	Rp 196.851.689,97
B4	Pile Cap Beksiting	m^2	121,28	Rp 242.270,50	Rp 29.381.354,89
B5	Pile Cap Reinforcement	kg	16.688,00	Rp 18.500,00	Rp 308.728.000,00
				Total Price of Footing Structure	**Rp 911.949.066,59**
SECTION C	**CONCRETE STRUCTURES**				
C1	Base Floor				
	- Tie Beam Concrete	m^3	43,16	Rp 1.180.497,76	Rp 50.944.380,69
	- Tie Beam Reinforcement	kg	6.013,30	Rp 18.500,00	Rp 111.246.042,60
	- Bekisting Tie Beam	m^2	299,46	Rp 262.395,50	Rp 78.576.956,43
	- Floor Deck Concrete	m^3	57,33	Rp 1.180.497,76	Rp 67.677.936,39
	- Floor Deck Reinforcement	kg	13.060,53	Rp 18.500,00	Rp 241.619.805,00
C2	1st Floor				
	- Floor Deck Concrete	m^3	53,92	Rp 1.180.497,76	Rp 63.649.487,79
	- Floor Deck Reinforcement	kg	12.291,80	Rp 18.500,00	Rp 227.398.207,50
	- Bekisting Floor Deck	m^2	395,00	Rp 802.725,88	Rp 317.076.720,63
	- Column Concrete	m^3	32,05	Rp 1.180.497,76	Rp 37.830.231,11
	- Column Reinforcement	kg	4.540,23	Rp 18.500,00	Rp 83.994.218,00
	- Bekisting Column	m^2	233,60	Rp 526.725,88	Rp 123.043.164,40
	- Beam Concrete	m^3	54,87	Rp 1.180.497,76	Rp 64.777.453,40
	- Beam Reinforcement	kg	7.656,71	Rp 18.500,00	Rp 141.649.042,50
	- Bekisting Beam	m^2	488,99	Rp 262.395,50	Rp 128.307.463,57
C3	2nd Floor				
	- Floor Deck Concrete	m^3	53,92	Rp 1.180.497,76	Rp 63.649.487,79
	- Floor Deck Reinforcement	kg	12.291,80	Rp 18.500,00	Rp 227.398.207,50
	- Bekisting Floor Deck	m^2	395,00	Rp 802.725,88	Rp 317.076.720,63
	- Column Concrete	m^3	32,05	Rp 1.180.497,76	Rp 37.830.231,11
	- Column Reinforcement	kg	4.540,23	Rp 18.500,00	Rp 83.994.218,00
	- Bekisting Column	m^2	233,60	Rp 526.725,88	Rp 123.043.164,40
	- Beam Concrete	m^3	54,87	Rp 1.180.497,76	Rp 64.777.453,40
	- Beam Reinforcement	kg	7.656,71	Rp 18.500,00	Rp 141.649.042,50
	- Bekisting Beam	m^2	488,99	Rp 262.395,50	Rp 128.307.463,57
C4	3rd Floor				
	- Floor Deck Concrete	m^3	53,92	Rp 1.180.497,76	Rp 63.649.487,79
	- Floor Deck Reinforcement	kg	12.291,80	Rp 18.500,00	Rp 227.398.207,50
	- Bekisting Floor Deck	m^2	395,00	Rp 802.725,88	Rp 317.076.720,63
	- Column Concrete	m^3	32,05	Rp 1.180.497,76	Rp 37.830.231,11
	- Column Reinforcement	kg	4.302,09	Rp 18.500,00	Rp 79.588.628,00
	- Bekisting Column	m^2	233,60	Rp 526.725,88	Rp 123.043.164,40
	- Beam Concrete	m^3	57,24	Rp 1.180.497,76	Rp 67.566.379,35
	- Beam Reinforcement	kg	7.703,19	Rp 18.500,00	Rp 142.508.922,50
	- Bekisting Beam	m^2	513,14	Rp 262.395,50	Rp 134.644.314,89
C5	4th Floor				
	- Floor Deck Concrete	m^3	53,92	Rp 1.180.497,76	Rp 63.649.487,79
	- Floor Deck Reinforcement	kg	12.244,16	Rp 18.500,00	Rp 226.517.006,25
	- Bekisting Floor Deck	m^2	407,50	Rp 802.725,88	Rp 327.110.794,06
	- Column Concrete	m^3	30,44	Rp 1.180.497,76	Rp 35.938.719,55
	- Column Reinforcement	kg	4.313,22	Rp 18.500,00	Rp 79.794.507,10
	- Bekisting Column	m^2	221,92	Rp 526.725,88	Rp 116.891.006,18
	- Beam Concrete	m^3	58,42	Rp 1.180.497,76	Rp 68.960.842,32
	- Beam Reinforcement	kg	7.825,97	Rp 18.500,00	Rp 144.780.352,50
	- Bekisting Beam	m2	525,21	Rp 262.395,50	Rp 137.812.740,56
C6	Roof Floor				
	- Floor Deck Concrete	m^3	41,48	Rp 1.180.497,76	Rp 48.961.144,46
	- Floor Deck Reinforcement	kg	10.662,32	Rp 18.500,00	Rp 197.252.827,50
	- Bekisting Floor Deck	m^2	407,50	Rp 802.725,88	Rp 327.110.794,06
	- Column Concrete	m^3	30,44	Rp 1.180.497,76	Rp 35.938.719,55
	- Column Reinforcement	kg	4.313,22	Rp 18.500,00	Rp 79.794.507,10
	- Bekisting Column	m^2	221,92	Rp 526.725,88	Rp 116.891.006,18
	- Beam Concrete	m^3	48,45	Rp 1.180.497,76	Rp 57.196.223,02
	- Beam Reinforcement	kg	5.439,78	Rp 18.500,00	Rp 100.635.874,50
	- Bekisting Beam	m2	436,72	Rp 262.395,50	Rp 114.593.690,75
				Total Price of Concrete Structure	**Rp 6.398.653.398,50**
				Amount	**Rp 7.313.962.465,09**
				Rounded	**Rp 7.313.963.000,00**



Grafik 4.3 S-Curve of structure building

V. CONCLUSION AND SUGGESTION

A. CONCLUSION

After design and analyze the structure of Building Office and Administrative Yayasan Al-Bahjah Cirebon, Can be concluded as follows :

1. The structure building use Special Momen Resisting Frame - SMRF (The location of building is included in the seismic design category D)
2. The earthquake analysis procedure uses Equivalent Lateral Analysis
3. Design structure of beam is used :
   a) 1st floor and 2nd floor using beams with dimensions 300 mm x 550 mm
   b) 3rd floor and 4th floor using beams with dimensions 300 mm x 550 mm
   c) Rooftop floor using beams with dimensions 300 mm x 500 mm
   d) Support beams used dimensions 250 mm x 450 mm
4. Design structure of column is used :
   a) Type of column K1 with dimension 500 mm x 500 mm (Pu -value = 1704,72)
   b) Type of column K2 with dimension 550 mm x 550 mm (Pu – value = 1829,57)
5. Design structure of slab is used :
   a) The thickness of Slab floor used 130 mm
   b) The thickness of Slab Rooftop used 100 mm
6. Design structure of foundation is used :
   a) Using a bored pile with a diameter of 50 cm, and has a carrying capacity of 77,10 Ton
   b) Group pile consist of 4 units, capable of holding a point load of 245,18 Ton
   c) Pilecap dimension is 2,75 m x 2,75 m x 0,75 m
7. Cost plan of building structure obtained Rp. 7.313.963.000,00

B. SUGGESTION

1. Before carrying out design and analyze it would be more appropriate to understand in advance the applicable regulations.
2. Before carrying out structural planning should to make an initial estimate of the size of the structural elements, so that there is no repeated a decision of structural elements.
3. In design the structural elements such us determining the reinforcements of slab, beam,

and column should be used that are almost similiar in size to facilitate of work in the field.

4. In planning the foundation should be use data from the actual location, so that the planning results can be in accordance with the conditions of the soil structure.
5. In inputting data on the ETABS program, it should be done carefully in accordance with the assumption or regulation that have been set previously so that a structural analysis can be produced that approaches the actual situation.
6. The used of structural analysis application accompanied by manual analysis as a comparison, to avoid input or modeling in application, doe to lack of thoroughness of the user.

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Pedoman Perencanaan Pembebanan untuk Rumah dan Gedung (PPIURG 1987)

PBI 1971 (Tabel Momen Plat Persegi Akibat Beban Merata)

TABEL MOMEN PRIMER – CROOS (SOEMONO)

Data Tanah Pembangunan Kantor CPDP Wil. Kabupaten Cirebon 1 Sumber

Kecapatan Angin Dasar BMKG