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ANALYSIS STRUCTURE OF THE NEW BUILDING PKU MUHAMMADIYAH ISLAMIC HOSPITAL TEGAL

Yusril Ramadhan*, Arief Firmanto**

*) Student of Civil Engineering Departement Faculty of Engineering Universitas Swadaya Gunung Jati Cirebon
**) Lecturer at Civil Engineering Departement Faculty of Engineering Universitas Swadaya Gunung Jati Cirebon

ABSTRACT

Muhammadiyah Islamic Hospital Tegal, built a 5 floor building to improve the quality of services in the health sector. Health access and more complete services in the district of Tegal are indeed expected by the community so that the community can get better health services.

Muhammadiyah Islamic Hospital Tegal used a reinforced concrete structure and designed with reference to SNI 1727 :2013, PPURG 1987, SNI 2847 :2013 and SNI 1726 :2012. The static equivalent and the dynamic response spectrum analysis method is used in analyzing earthquakes load. The earthquake force on the structure is used a configuration of the structure of the Special Moment Resisting Frame System (SMRFS). Analysis structure at this building used a software ETABS v9.6.0 to help structure modeling and calculate internal forces acting on the structure.

Keyword: *SNI 1727:2013, PPURG 1987, SNI 2847:2013, SNI 1726:2013, Response Spectrum, Lateral Equivalent Analysis, SMRF, ETABS v9.6.0*

I. INTRODUCTION

A. BACKGROUND

Tegal Regency, precisely in Adiwerna Subdistrict, which really needs an improvement in health services, the new PKU Muhammadiyah Islamic Hospital was built, which had already existed before. Health is very important in developing a region, if the people in the area have good health, then the community will also be able to carry out their roles in the economic field and other fields well. Therefore, the construction of the PKU Muhammadiyah Islamic Hospital Building is expected to improve health services and the comfort of the surrounding community, especially in the Adiwerna area.In the construction of building there is a structural analysis that serves as a way or system to achieve development as planned. With its proliferation era structure analysis can be assisted by the help of ETABS applications.

B. FOCUS PROBLEM

This study focused on analysis the structure of the New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal with structure analysis program (ETABS).

C. PROBLEM FORMULATION

1) How is the structure feasibility of the New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal ?
2) How to analyze dimension and reinforcement of slab, beam and column ?
3) How seismic force that occur in the structure New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal ?
4) How to calculate the structure budget of New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal ?

D. LIMITATION OF PROBLEM

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

a) Just analyze the main structure :
   - Tie Beam / Sloof
   - Beam
   - Column
   - Slab
   - Pile Cap & Pile Foundation

b) Just analyze the building structure
c) Used ETABS (*Extended Three Dimensional Analysis of Building System)*
d) Calculate the seismic forces that occur in the structure of the building with the Static Lateral Equivalent and Dynamic Response Spectrum Analysis method in accordance with SNI 1726-2012 about earthquake resistance planning procedures for building and non-building structures.
e) Calculating the budget of the structure only.

E. RESEARCH OBJECTIVES

a) Can analyze the structure feasibility of New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal
b) Can analyze structure New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal building with ETABS.
c) Can analyze the seismic forces that occur in the building structure.
d) Can estimating the Budget Plan (RAB) Building Structure.

F. RESEARCH BENEFITS

1. **The theoretical aspect**
2. **The practical aspect**

II. LITERATURE AND BASIC THEORY

A. RESEARCH THAT HAS BEEN DONE BEFORE

1. First, Research conducted by Wahyudi (2015) with the title **Analisis Struktur Statis Tak Tentu Dengan SAP2000**. This research is to compare the calculation of statically indeterminate (statis tak tentu) on the building structure 3D frame, the calculation used SAP 2000 and used Metric (slope deflection method).
2. Second, Research conducted by Aries Saputra (2017) with the title **Analisis Struktur Rumah Sakit Permata**

Cirebon. This research is to analyzed the structure design of the Permata Cirebon Hospital, the calculation used ETABS.

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. 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, which do not include the burden of construction and environmental loads, such as wind loads, loads of rain, earthquake loads, load floods , or dead load (SNI 1727:2013 pasal 4.1).

Table 2.2. Live Load SNI 1727-2013

Hunian atau penggunaan	Merata psf (kN/m²)	Terpusat lb (kN)
Apartemen (lihat rumah tinggal)		
Balkon dan dek	100 (4,79)	
Bilik mesin lift	150 (7,18)	
Gedung perkantoran:		
Ruang arsip dan komputer harus dirancang untuk beban yang lebih berat berdasarkan pada perkiraan hunian	150 (7,18)	
Lobi dan koridor lantai pertama	100 (4,79)	2 000 (8,90)
Kantor	50 (2,40)	2 000 (8,90)
Koridor di atas lantai pertama	80 (3,83)	2 000 (8,90)
Lembaga hukum		
Blok sel	40 (1,92)	
Koridor	100 (4,79)	
Tempat rekreasi		
Tempat bowling, Kolam renang, dan penggunaan yang sama	75 (3,59)	
Bangsal dansa dan Ruang dansa	100 (4,79)	
Gimnasium	100 (4,79)	
Tempat menonton beratap terbuka atau tertutup	100 (4,79)	
Stadium dan tribun/arena dengan tempat duduk tetap (terikat pada lantai)	60 (2,87)	
Rumah tinggal		
Hunian (satu keluarga dan dua keluarga)		
Loteng yang tidak dapat didiami tanpa gudang	10 (0,48)	
Loteng yang tidak dapat didiami dengan gudang	20 (0,96)	
Loteng yang dapat didiami dan ruang tidur	30 (1,44)	
Semua ruang kecuali tangga dan balkon	40 (1,92)	
Semua hunian rumah tinggal lainnya		
Ruang pribadi dan koridor yang melayani mereka	40 (1,92)	
Ruang publik dan koridor yang melayani mereka	100 (4,79)	

b. Horizontal Load

1) Earthquake Load

Earthquake load is a phenomenon caused by the impact or tectonics plate friction of the earth fault occurs in the fault zone. In the event of a clash between the active tectonic plates of the earth, there will be the release of seismic energy in the form of energy waves that propagate in or on the surface of the earth (Hima Indarto, 2009).

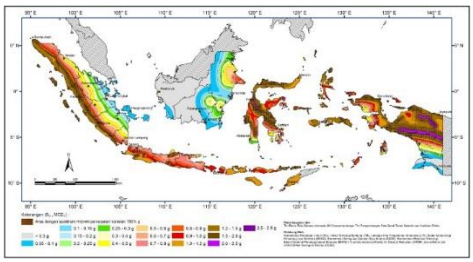


Figure 2.1. Peta gerak tanah seismik dan koefisien resiko

- Site class = Categories SD (medium)
- Earthquake acceleration parameter (Ss,S1) for the location of PKU Muhammadiyah Hospital Tegal with latitude *-6.930561111* and *longitude 109.1279944* is Ss = 0,704 g and S1 = 0,290 g
- Earthquake acceleration response parameter S_{MS} = 0,871 and S_{M1} = 0,528
- Seismic design category
  S_{DS} = 0,580 ≥ 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)
LANTAI 1	2908,74	1702,435	13647,135	18258,360
LANTAI 2	2908,74	1353,905	7571,449	11834,094
LANTAI 3	2683,06	1353,905	7571,449	116108,04
LANTAI 4	2683,06	1353,905	7571,449	116108,04
LANTAI 5	636,3	339,36	8125,088	9100,748
			44486,62	62410,03

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 Jl. Singkil Km. 05 Kecamatan Adiwerna Kabupaten Tegal.
  V = 6,83508 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)

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* = $(0{,}9_{SW} + 0{,}9_{DL}) + 1{,}0_{Wy}$

4. 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
  $\frac{\ln(0{,}8+\frac{fy}{1400})}{36+5\beta(\alpha\, \boldsymbol{fm}-0{,}2)}$ for $(0.2 < \alpha\boldsymbol{fm} < 2.0)$
- Momen of slab (PBI 1971)
  $Mlx^{(+)} = 0{,}001 \cdot Qu \cdot lx^2 \cdot Clx$
  $Mly^{(+)} = 0{,}001 \cdot Qu \cdot lx^2 \cdot Cly$
  $Mtx^{(-)} = -0{,}001 \cdot Qu \cdot lx^2 \cdot Ctx$
  $Mty^{(-)} = -0{,}001 \cdot Qu \cdot lx^2 \cdot Cty$
- 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

ρ =

$$\frac{0{,}8fy-\sqrt{(0{,}8fy)^2-4\,x\left(0{,}4704\,x\,\frac{fy^2}{fc}\right)x\left(\frac{Mu}{bd^2}\right)}}{2\,x\left(0{,}4704\,x\,\frac{fy^2}{fc}\right)}$$

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

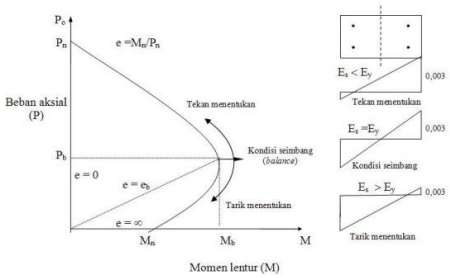
  Vc = $\phi\left(\frac{1}{6}\sqrt{fc'}\right) x\, b\, x\, d'$, with Ø = 0,75

- 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 (Pile)

Pile foundation is part of the structure used to receive and transfer (distribute) the load from the upper structure to the supporting soil which is located at a certain depth..

- Daya Dukung Tiang Pancang

  Q_p = ((qc x Ap)/3) + ((JHL x Ka)/5)

- Daya Gesek Tiang Pancang

  Q_s = K.σ tan (0,8 x ϕ) p L

- Daya Dukung Ultimate Tiang Pancang

  Q_{ull} = Qp + Qs

- 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, the explanation are, as follows:

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 data to be used as a preparation of the thesis. The data obttained are data from the object research. There are :

- SPT data
- Building Area
- Shop Drawing for Structure Work

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 are the data obtained from survey and direct observation to the location or object research.
b) Secondary data is data obtained from references, books and the internet related to the building design.

3. Collecting Data Method

Collection data method used are the literature method and observation method, the explanation as follows :

a) The literature method are the method performed by collecting, learning, and identifying from literature, that comes from books and the internet, which is related to the building design..
b) The observation method are the method obtained from survey directly, to the location or object research. With the survey to location of research, it can be seen and obtain data on the structural design of PKU Muhammadiyah Hospital Tegal.

4. Analysis Data Method

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

a) Preparation Stage
b) Problem Stage
c) Study Literature Stage
d) Collection Data Stage
e) Analysis Stage
f) The Budget Planning Stage

B. LOCATION OF RESEARCH

The research location of New Building PKU Muhammadiyah Islamic Hospital Kabupaten Tegal located at Jl. Singkil Km. 05 Kecamatan Adiwerna Jawa Tengah.

C. FLOW OF RESEARCH

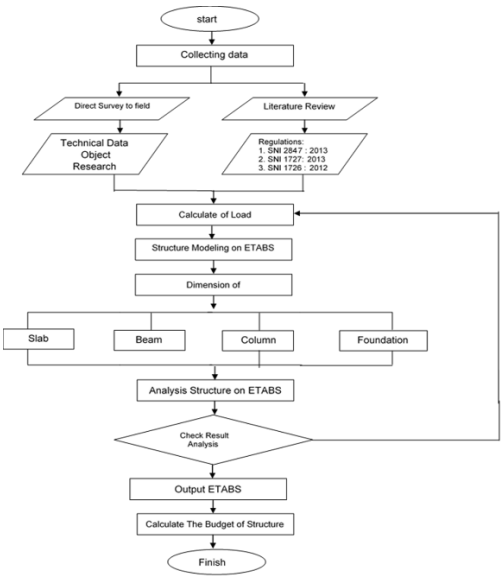


Figure 3.1 Flowchart of research methodology

IV. DESIGN AND ANALYSIS

A. MODEL OF STRUCTURE

Analysis structure of the PKU Muhammadiyah Hospital, Tegal is carried out by *finite element* for various combinations of loading which include dead loads, live loads and earthquake loads by modeling 3-D structures (*space-frames*). Structural modeling is done with the ETABS v9.6.0 (Three-*ExtendedAnalysis Analysis Building System*) program as shown in Figure 4.1

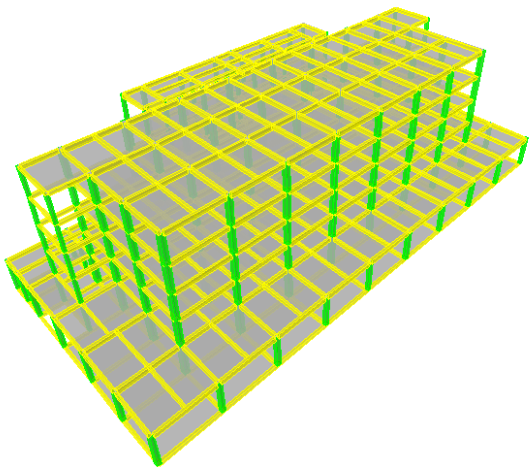


Figure 4.1 Model Structure on ETABS v.9.6.0

B. REGULATION AND STANDARD

a. Pedoman Perencanaan Pembebanan Untuk Rumah Dan Gedung (PPPURG 1987)

b. Tata cara Perencanaan Ketahanan Gempa untuk Bangunan Gedung (SNI 1726 :2012)

c. Beban Minimum untuk Perancangan Bangunan Gedung dan Struktur Lain (SNI 1727 :2013)

d. Persyaratan Beton Struktural untuk Bangunan Gedung (SNI 2847 :2013)

C. MATERIAL STRUCTURES

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

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

b) Rebar

Longitudinal rebar : BJTD 40 (fy 400 Mpa)

Transversal rebar : BJTP 40 (fy 240 Mpa)

Reinforcement Diameters:

- Slab : D 10, D 8
- Beam : D19, D22 (main reinforcement) & D10 (stirrup reinforcement)
- Column : D 19 (main reinforcement) & D10 (stirrup reinforcement)

D. DIMENSION OF STRUCTURAL ELEMENTS

Table 4.1 Structure dimensions

Type of Structure	Type / Code	Dimensions (mm)
Slab	Slab 2nd-Rooftop	130
	Slab 1st Floor	120
Beam	S1	300/700
	S2	300/500
	B1	300/700
	B2	300/600
	B3	300/500
	B4	300/500
Column	K1	600 x 600
	K2	400 x 400
	K3	300 x 500
	K4	400 x 400
	K5	400 x 400
Pile Cap	PC1	2000 x 2000 x 800
	PC2	2800 x 800 x 800
Pile	P	Ø400

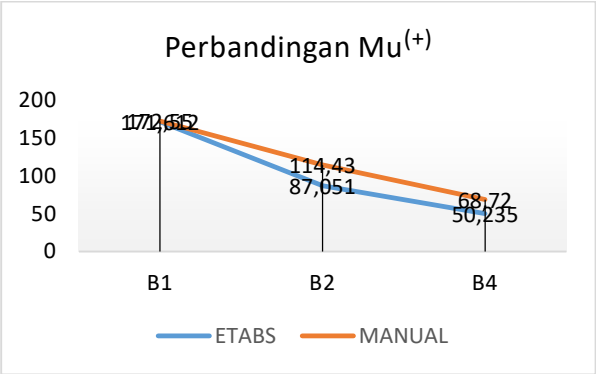
E. ANALYSIS STRUCTURE

1. Structure Reinforcement

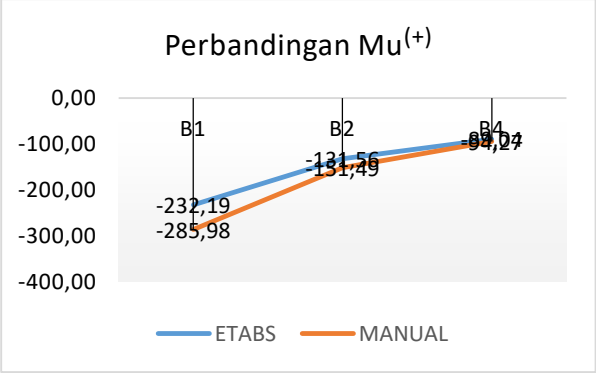
In calculating structure reinforcement (there are Beam, Column, Slab, Pile Cap, Pile) used output ETABS analysis and manual analysis as comparison.

Table 4.2 Comparison force of beam in ETABS analysis with Manual analysis

Frame	Name Label (Story)	ETABS Analysis					Manual Analysis			Validasi (%)
		Load	Location	M3	Vu	δ_{max}	Mu	Vu	δ	
B1	B337 (Lantai 2)	KOMBO2	4	171.61	112.16	4.00	172.55	238.26	10.571	0.54
		KOMBO4	7.65	-232.19			-285.98			18.81
B2	B324 (Lantai 2)	KOMBO4	1.775	87.05	87.89	3.25	114.43	128.91	5.231	23.93
		KOMBO4	6.2	-131.56			-151.49			13.16
B4	B469 (Lantai 2)	KOMBO4	0.2	50.24	63.48	2.08	68.72	118.71	4.419	26.89
		KOMBO4	6.3	-89.04			-94.27			5.55



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 4.3 Recapitulation of Beam reinforcement

Types Beam	Location	ETABS Analysis		Manual Analysis		Analysis reinforcement	
		Longitudinal (mm^2)	Shear (mm^2)	Longitudinal (mm^2)	Shear (mm^2)	Longitudinal (D)	Shear (Ø)
S1 (300 x 700)	Support	405	0.259	600	0.43	4 D 19	10 - 150
	Field	201		600		4 D 19	
S2 (300 x 500)	Support	465	0.259	413	0.521	3 D 19	10 - 150
	Field	246		413		3 D 19	
B1 (300 x 4700)	Support	1074	0.561	1511	1.18	6 D 22	10 - 100
	Field	800		882		4 D 22	
B2 (300 x 600)	Support	720	0.523	928	0.79	5 D 22	10 - 150
	Field	458		691		3 D 22	
B3 (300 x 500)	Support	476	0.285	413	0.471	3 D 19	10 - 150
	Field	140		413		3 D 19	
B4 (300 x 500)	Support	593	0.46	463	0.79	3 D 19	10 - 150
	Field	325		463		3 D 19	

Table 4.4 Maximum value of Axial force (Pu) and Momen (Mu) Column

Column Type	Name Label	Combo	Location	Gaya Aksial (Pu) kN	Momen (Mu) kNm
K1 (700 X 700)	C145	KOMBO2-1	0	-3556.92	279.641
K1 (600 X 600)	C145	KOMBO2-1	0	-2750.51	173.357
K2 (400 X 400)	C143	KOMBO2-1	0	-587.63	46.588
K3 (300 X 500)	C177	KOMBO2-1	0	-1027.92	54.761
K4 (400 X 400)	C168	KOMBO2-1	0	-396.81	45.53
K5 (500 X 500)	C111	KOMBO2-1	0	-415.59	167.415
K8 (500 X 500)	C126	KOMBO2-1	0	-463.65	112.698

Table 4.5 Recapitulation of Column reinforcement

Column Type	$A_{s\ perlu}$	Digunakan Tulangan			$A_{s\ aktual}$	Cek	$A_{vs,perlu}$	Digunakan Tulangan			$A_{vs,aktual}$	Cek
		Ø	Luas	n				Ø	Luas	Jarak		
K1 (600 x 600)	3600	19	284	14	3969	Aman	0.72	10	157	100	1.57	Aman
K2 (400 x 400)	1600	19	284	18	5104	Aman	0.12	10	157	100	1.57	Aman
K5 (500 x 500)	2500	19	284	16	4536	Aman	0.40	10	157	100	1.57	Aman
K8 (400 x 400)	1600	19	284	12	3402	Aman	0.11	10	157	100	1.57	Aman

Table 4.6 Recapitulation of Slab reinforcement

Type Pelat	Function	Reinforcement	
		X- direction (mm)	Y- direction (mm)
A2 (6,5 x 4m)	1st Floor	D 13 - 200	D 13 - 200
A2 (5 x 3m)		D 13 - 200	D 13 - 200
A2 (8 x 6,5m)		D 13 - 200	D 13 - 200
A1(6,5 x 4m)	2nd-5th Floor	D 13 - 150	D 13 - 150
A1(3 x 5m)		D 13 - 150	D 13 - 150
A1(6,5 x 4m)	Rooftop	D 13 - 150	D 13 - 150
A1(3 x 5m)		D 13 - 150	D 13 - 150

Table 4.7 Recapitulation of support reaction

Story	Point	Load	FX	FY	FZ
BASE	237	COMB2	63.17	1.72	757.04
BASE	271	COMB2	0.24	3.27	4226.75

Table 4.8 Group pile efficiency

POER	Efisiensi	N TP	Q all	1 TP Eff.	Eff. Group	Cek
1	0.863	3	144.55	124.746	374.239	YES
2	0.795	4	144.55	114.917	459.668	YES
3	0.761	6	144.55	110.002	660.014	YES

***Note:**

From the table above can be described as follows ;

The value of group pile efficiency at poer 1 was tried with the number of pile as much as 4 , shown $Q_{eff.group} > Q_{pilecap}$ (459,668 < 352,229) means comply the requirements (YES)

Table 4.12 Cost plan of structure building

NO	URAIAN PEKERJAAN	UNIT	VOLUME	UNIT PRICE (Rp)	TOTAL PRICE (Rp)
	PEKERJAAN STRUKTUR				
	PROYEK RUMAH SAKIT ISLAM PKU MUHAMMADIYAH TEGAL				
1	**PREPARATION WORK**				
	1.1 Site Clearing	m2	2325.60	8,000.00	18,604,800.00
	1.2 Bouwplank Board	m	212.60	59,000.00	12,543,400.00
2	**FOUNDATION WORK**				
	2.1 Pile uk 40x40 cm, P=12m	m	2172.00	439,300.00	954,159,600.00
	2.2 Break the head of Pile	m	181.00	150,000.00	27,150,000.00
	2.3 Soil Excavation of Pilecap	m3	143.97	32,370.00	4,660,308.90
	2.4 Sand Fill of Pilecap t=10cm	m3	17.90	282,110.00	5,048,640.56
	2.5 Work of Pilecap Type P1				
	Pilecap Reinforcement	kg	5376.91	14,400.00	77,427,504.00
	Pilecap Formwork	m2	204.80	136,300.00	27,914,240.00
	Pilecap Concrete fc'=25 Mpa	m3	102.4	1,180,498.00	120,882,995.20
	2.6 Work of Pilecap Type P2				
	Pilecap Reinforcement	kg	822.73	14,400.00	11,847,312.00
	Pilecap Formwork	m2	23.04	136,300.00	3,140,352.00
	Pilecap Concrete fc'=25 Mpa	m3	7.17	1,180,498.00	8,464,170.66
	2.7 Work of Pilecap Type P3				
	Pilecap Reinforcement	kg	6508.82	14,400.00	93,727,008.00
	Pilecap Formwork	m2	178.88	136,300.00	24,381,344.00
	Pilecap Concrete fc'=25 Mpa	m3	49.54	1,180,498.00	58,477,148.93
	2.7 Work of Sloof S1 300x700				
	Sloof Reinforcement	kg	18667.48	14,400.00	268,811,712.00
	Sloof Formwork	m2	646.00	136,300.00	88,049,800.00
	Sloof Concrete fc'=25 Mpa	m3	79.80	1,180,498.00	94,203,740.40
	2.8 Work of Sloof S2 300x500				
	Sloof Reinforcement	kg	5059.80	14,400.00	72,861,120.00
	Sloof Formwork	m2	412.10	136,300.00	56,169,230.00
	Sloof Concrete fc'=25 Mpa	m3	47.55	1,180,498.00	56,132,679.90
3	**STRUCTURE WORK**				
3.1	FIRST FLOOR				
	3.1.1 Slab concrete h=13 cm , fc'=25 Mpa	m3	243.36	1,180,498.00	287,285,993.28
	3.1.2 Slab reinforcement	kg	19806.34	14,400.00	285,211,296.00
	3.1.3 Slab Formwork	m2	1872.00	125,320.00	234,599,040.00
	3.1.4 Column 70/70 fc'=25 Mpa (K1)	m3	78.40	1,180,498.00	92,551,043.20
	Reinforcement Column	kg	9,175.04	14,400.00	132,120,576.00
	Column Formwork	m2	448.00	526,726.00	235,973,248.00
	3.1.5 Column 40/40 fc'=25 Mpa (K2)	m3	3.20	1,180,498.00	3,777,593.60
	Reinforcement Column	kg	998.80	14,400.00	14,382,720.00
	Column Formwork	m2	32.00	526,726.00	16,855,232.00
	3.1.5 Column 30/50 fc'=25 Mpa (K3)	m3	15.00	1,180,498.00	17,707,470.00
	Reinforcement Column	kg	4103.2	14,400.00	59,086,080.00
	Column Formwork	m2	160.00	526,726.00	84,276,160.00
	3.1.6 Column 40/40 fc'=25 Mpa (K4)	m3	9.60	1,180,498.00	11,332,780.80
	Reinforcement Column	kg	2107.20	14,400.00	30,343,680.00
	Column Formwork	m2	96.00	526,726.00	50,565,696.00
	3.1.7 Column 50/50 fc'=25 Mpa (K5)	m3	12.50	1,180,498.00	14,756,225.00
	Reinforcement Column	kg	2397.80	14,400.00	34,528,320.00
	Column Formwork	m2	100.00	526,726.00	52,672,600.00
	3.1.8 Column 50/50 fc'=25 Mpa (K8)	m3	10.00	1,180,498.00	11,804,980.00
	Reinforcement Column	kg	1562.08	14,400.00	22,493,952.00
	Column Formwork	m2	80.00	526,726.00	42,138,080.00
	3.1.9 Beam 30/70 fc'=25 Mpa (B1)	m3	60.48	1,180,498.00	71,396,519.04
	Reinforcement Beam	kg	19028.16	14,400.00	274,005,504.00
	Beam Formwork	m2	576.00	262,395.00	151,139,520.00
	3.1.10 Beam 30/60 fc'=25 Mpa (B2)	m3	46.80	1,180,498.00	55,247,306.40
	Reinforcement Beam	kg	13531.04	14,400.00	194,846,976.00
	Beam Formwork	m2	520.00	262,395.00	136,445,400.00
	3.1.11 Beam 30/50 fc'=25 Mpa (B3)	m3	39.00	1,180,498.00	46,039,422.00
	Reinforcement Beam	kg	10235.15	14,400.00	147,386,160.00
	Beam Formwork	m2	416.00	262,395.00	109,156,320.00
	3.1.11 Beam 30/50 fc'=25 Mpa (B4)	m3	10.80	1,180,498.00	12,749,378.40
	Reinforcement Beam	kg	3156.72	14,400.00	45,456,768.00
	Beam Formwork	m2	115.20	262,395.00	30,227,904.00
3.2	SECOND FLOOR				
	3.2.1 Slab concrete h=13 cm , fc'=25 Mpa	m3	182.52	1,180,498.00	215,464,494.96
	3.2.2 Slab reinforcement	kg	34604.82	14,400.00	498,309,408.00
	3.2.3 Slab Formwork	m2	1,404.00	125,320.00	175,949,280.00
	3.2.4 Column 60/60 fc'=25 Mpa (K1)	m3	46.08	1,180,498.00	54,397,347.84
	Reinforcement Column	kg	5884.54	14,400.00	84,737,376.00
	Column Formwork	m2	307.20	526,726.00	161,810,227.20
	3.2.5 Column 40/40 fc'=25 Mpa (K2)	m3	2.56	1,180,498.00	3,023,074.88
	Reinforcement Column	kg	799.03	14,400.00	11,506,032.00
	Column Formwork	m2	25.60	526,726.00	13,484,185.60
	3.2.6 Column 30/50 fc'=25 Mpa (K3)	m3	12.00	1,180,498.00	14,165,976.00
	Reinforcement Column	kg	3282.96	14,400.00	47,274,624.00
	Column Formwork	m2	128.00	526,726.00	67,420,928.00
	3.2.7 Beam 30/70 fc'=25 Mpa (B1)	m3	47.04	1,180,498.00	55,530,625.92
	Reinforcement Beam	kg	14799.68	14,400.00	213,115,392.00
	Beam Formwork	m2	448.00	262,395.00	117,552,960.00
	3.2.8 Beam 30/60 fc'=25 Mpa (B2)	m3	28.08	1,180,498.00	33,148,383.84
	Reinforcement Beam	kg	7958.70	14,400.00	114,605,280.00
	Beam Formwork	m2	280.80	262,395.00	73,680,516.00
	3.2.9 Beam 30/50 fc'=25 Mpa (B3)	m3	20.48	1,180,498.00	24,176,599.04
	Reinforcement Beam	kg	5373.45	14,400.00	77,377,680.00
	Beam Formwork	m2	218.4	262,395.00	57,307,068.00
	3.2.10 Beam 30/50 fc'=25 Mpa (B4)	m3	10.80	1,180,498.00	12,749,378.40
	Reinforcement Beam	kg	3156.72	14,400.00	45,456,768.00
	Beam Formwork	m2	115.20	262,395.00	30,227,904.00
3.3	THIRD FLOOR				
	3.3.1 Slab concrete h=13 cm , fc'=25 Mpa	m3	183.57	1,180,498.00	315,984,991.86
	3.3.2 Slab reinforcement	kg	34604.82	14,400.00	498,309,408.00
	3.3.3 Slab Formwork	m2	1,404.00	125,320.00	175,949,280.00
	3.3.4 Column 60/60 fc'=25 Mpa (K1)	m3	46.08	1,180,498.00	54,397,347.84
	Reinforcement Column	kg	5884.54	14,400.00	84,737,376.00
	Column Formwork	m2	307.20	526,726.00	161,810,227.20
	3.3.5 Column 40/40 fc'=25 Mpa (K2)	m3	2.56	1,180,498.00	3,023,074.88
	Reinforcement Column	kg	799.03	14,400.00	11,506,032.00
	Column Formwork	m2	25.60	526,726.00	13,484,185.60
	3.3.6 Column 30/50 fc'=25 Mpa (K3)	m3	12.00	1,180,498.00	14,165,976.00
	Reinforcement Column	kg	3282.96	14,400.00	47,274,624.00
	Column Formwork	m2	128.00	526,726.00	67,420,928.00
	3.3.7 Beam 30/70 fc'=25 Mpa (B1)	m3	47.04	1,180,498.00	55,530,625.92
	Reinforcement Beam	kg	14799.68	14,400.00	213,115,392.00
	Beam Formwork	m2	448.00	262,395.00	117,552,960.00
	3.3.8 Beam 30/60 fc'=25 Mpa (B2)	m3	28.08	1,180,498.00	33,148,383.84
	Reinforcement Beam	kg	7958.70	14,400.00	114,605,280.00
	Beam Formwork	m2	280.80	262,395.00	73,680,516.00
	3.3.9 Beam 30/50 fc'=25 Mpa (B3)	m3	20.48	1,180,498.00	24,176,599.04
	Reinforcement Beam	kg	5373.45	14,400.00	77,377,680.00
	Beam Formwork	m2	218.4	262,395.00	57,307,068.00
	3.3.10 Beam 30/50 fc'=25 Mpa (B4)	m3	10.80	1,180,498.00	12,749,378.40
	Reinforcement Beam	kg	3156.72	14,400.00	45,456,768.00
	Beam Formwork	m2	115.20	262,395.00	30,227,904.00
3.4	FOURTH FLOOR				
	3.4.1 Slab concrete h=13 cm , fc'=25 Mpa	m3	183.57	1,180,498.00	315,984,991.86
	3.4.2 Slab reinforcement	kg	34604.82	14,400.00	498,309,408.00
	3.4.3 Slab Formwork	m2	1,404.00	125,320.00	175,949,280.00
	3.4.4 Column 60/60 fc'=25 Mpa (K1)	m3	46.08	1,180,498.00	54,397,347.84
	Reinforcement Column	kg	5884.54	14,400.00	84,737,376.00
	Column Formwork	m2	307.20	526,726.00	161,810,227.20
	3.4.5 Column 40/40 fc'=25 Mpa (K2)	m3	2.56	1,180,498.00	3,023,074.88
	Reinforcement Column	kg	799.03	14,400.00	11,506,032.00
	Column Formwork	m2	25.60	526,726.00	13,484,185.60
	3.4.6 Column 30/50 fc'=25 Mpa (K3)	m3	12.00	1,180,498.00	14,165,976.00
	Reinforcement Column	kg	3282.96	14,400.00	47,274,624.00
	Column Formwork	m2	128.00	526,726.00	67,420,928.00
	3.4.7 Beam 30/70 fc'=25 Mpa (B1)	m3	47.04	1,180,498.00	55,530,625.92
	Reinforcement Beam	kg	14799.68	14,400.00	213,115,392.00
	Beam Formwork	m2	448.00	262,395.00	117,552,960.00
	3.4.8 Beam 30/60 fc'=25 Mpa (B2)	m3	28.08	1,180,498.00	33,148,383.84
	Reinforcement Beam	kg	7958.70	14,400.00	114,605,280.00
	Beam Formwork	m2	280.80	262,395.00	73,680,516.00
	3.4.9 Beam 30/50 fc'=25 Mpa (B3)	m3	20.48	1,180,498.00	24,176,599.04
	Reinforcement Beam	kg	5373.45	14,400.00	77,377,680.00
	Beam Formwork	m2	218.4	262,395.00	57,307,068.00
	3.4.10 Beam 30/50 fc'=25 Mpa (B4)	m3	10.80	1,180,498.00	12,749,378.40
	Reinforcement Beam	kg	3156.72	14,400.00	45,456,768.00
	Beam Formwork	m2	115.20	262,395.00	30,227,904.00
3.5	FIFTH FLOOR				
	3.5.1 Slab concrete h=13 cm , fc'=25 Mpa	m3	183.57	1,180,498.00	315,984,991.86
	3.5.2 Slab reinforcement	kg	34604.82	14,400.00	498,309,408.00
	3.5.3 Slab Formwork	m2	1,404.00	125,320.00	175,949,280.00
	3.5.4 Column 60/60 fc'=25 Mpa (K1)	m3	46.08	1,180,498.00	54,397,347.84
	Reinforcement Column	kg	5884.54	14,400.00	84,737,376.00
	Column Formwork	m2	307.20	526,726.00	161,810,227.20
	3.5.5 Column 40/40 fc'=25 Mpa (K2)	m3	2.56	1,180,498.00	3,023,074.88
	Reinforcement Column	kg	799.03	14,400.00	11,506,032.00
	Column Formwork	m2	25.60	526,726.00	13,484,185.60
	3.5.6 Column 30/50 fc'=25 Mpa (K3)	m3	12.00	1,180,498.00	14,165,976.00
	Reinforcement Column	kg	3282.96	14,400.00	47,274,624.00
	Column Formwork	m2	128.00	526,726.00	67,420,928.00
	3.5.7 Beam 30/70 fc'=25 Mpa (B1)	m3	47.04	1,180,498.00	55,530,625.92
	Reinforcement Beam	kg	14799.68	14,400.00	213,115,392.00
	Beam Formwork	m2	448.00	262,395.00	117,552,960.00
	3.5.8 Beam 30/60 fc'=25 Mpa (B2)	m3	28.08	1,180,498.00	33,148,383.84
	Reinforcement Beam	kg	7958.70	14,400.00	114,605,280.00
	Beam Formwork	m2	280.80	262,395.00	73,680,516.00
	3.5.9 Beam 30/50 fc'=25 Mpa (B3)	m3	20.48	1,180,498.00	24,176,599.04
	Reinforcement Beam	kg	5373.45	14,400.00	77,377,680.00
	Beam Formwork	m2	218.4	262,395.00	57,307,068.00
	3.5.10 Beam 30/50 fc'=25 Mpa (B4)	m3	10.80	1,180,498.00	12,749,378.40
	Reinforcement Beam	kg	3156.72	14,400.00	45,456,768.00
	Beam Formwork	m2	115.20	262,395.00	30,227,904.00
				Total Price of Structure	12,203,909,088.29

V. CONCLUSION AND SUGGESTION

A. CONCLUSION

After carrying out the analysis and design of the building structure of Muhammadiyah Islamic Hospital Tegal which was adjusted to the Tata Cara Perencanaan Gempa untuk Struktur Bangunan Gedung dan Non Gedung (SNI-1726-2012), Persyaratan Beban Minimum untuk Perancangan Bangunan Gedung dan Struktur Lain (SNI-1727-2013) and Persyaratan Beton Struktural untuk Bangunan Gedung (SNI-2847-2013), conclusions can be taken 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 and Response Spectrum Analysis
3. Design structure of beam is used :
   a) Beams (B1) with dimensions 300 mm x 700 mm
   b) Beams (B2) with dimensions 300 mm x 600 mm
   c) Beams (B3) with dimensions 300 mm x 500 mm
   d) Beams (B4) with dimensions 300 mm x 500 mm
4. Design structure of column is used :
   a) Type of column K1 with dimension 600 mm x 600 mm
   b) Type of column K2 with dimension 400 mm x 400 mm
   c) Type of column K3 with dimension 300 mm x 500 mm
   d) Type of column K4 with dimension 400 mm x 400 mm
   e) Type of column K5 with dimension 500 mm x 500 mm
   f) Type of column K8 with dimension 500 mm x 500 mm
5. Design structure of slab is used :
   a) The thickness of Slab floor used 130 mm
   b) The thickness of Ground Floor used 120 mm
6. The difference analysis reinforcement between applied reinforcement :

Type	Location	Analysis Reinforcement							Applied Reinforcement						
		Longitudinal (D)			Shear			(Ø)	Longitudinal (D)			Shear			(Ø)
S1 (300 x 700)	Support	4	D	19	D	10	-	150	4	D	19	D	10	-	150
	Field	4	D	19					4	D	19				
S2 (300 x 500)	Support	3	D	19	D	10	-	150	3	D	19	D	10	-	150
	Field	3	D	19					3	D	19				
B1 (300 x 700)	Support	6	D	22	D	10	-	100	7	D	22	D	10	-	100
	Field	4	D	22					5	D	22				
B2 (300 x 600)	Support	5	D	22	D	10	-	150	6	D	22	D	10	-	150
	Field	3	D	22					3	D	22				
B3 (300 x 500)	Support	3	D	19	D	10	-	150	4	D	19	D	10	-	150
	Field	3	D	19					4	D	19				
B4 (300 x 500)	Support	3	D	19	D	10	-	150	4	D	19	D	10	-	150
	Field	3	D	19					4	D	19				
S-A1 (130mm)	X	D	13	-	150				D	10	-	150			
	Y	D	13	-	150				D	10	-	200			
S-A2 (120mm)	X	D	13	-	200				Ø	8	-	200			
	Y	D	13	-	200				Ø	8	-	200			

7. Cost plan of building structure obtained Rp. 13,903,099,088,00
8. Design structure of foundation is used :
   a) Using a pile with a diameter of 40 cm, and has a carrying capacity of 297,845 kN
   b) There are 2 types of Pilecap that is PC-1 and PC-2
   c) PC-1 with dimension 2 m x 2m and PC-2 with dimension 2,8 m x 0,8 m
9. The dimensions of columns, beams and slabs according to manual calculations are in accordance with the dimensions installed in the field, so the dimensions of Column and Beams of Muhammadiyah Hospital in Tegal are considered feasible.

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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Badan Standarisasi Nasional. ***Tata Cara Perencanaan Ketahanan Gempa untuk Struktur Bangunan Gedung dan Non-Gedung*** (SNI 1726 – 2012)

Pedoman Perencanaan Pembebanan untuk Rumah dan Gedung (PPIURG 1987)

PBI 1971 (Tabel Momen Plat Persegi Akibat Beban Merata)

TABEL MOMEN PRIMER – CROOS (SOEMONO)

Kecapatan Angin Dasar BMKG