3 Floor Luxury House Structure Design Planning Using Etabs Software

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Abstract* — Structural planning is a mixture of basics with science in structural analysis, statics, mechanics of materials and dynamics to obtain structures that are safe and economical in their service life. The purpose of this study was to plan the dimensions of the building's portal structure that can withstand loads safely. This research was conducted in Karang Asem 1, Kuningan, Setia Budi, South Jakarta. The final result of structural planning can be concluded that there are several beams used including, 450/600 beams, 450/700 beams, 500/700 beams, 550/700 beams, 600/750 beams, 450/650 beams, 400 beams /550, and ring beams. All of the above beams use D16 longitudinal reinforcement with d10 stirrup reinforcement. while the columns used are 400/350 columns, 400/400 columns, 450/450 columns and 450/500 columns using D16 longitudinal reinforcement with d10 stirrup reinforcement. And the 650/650 column uses D22 for longitudinal reinforcement and d10 for stirrup reinforcement.
Keywords: Reinforced concrete structure, ETABS software, Planning, design, house, 3rd floor

I. INTRODUCTION

Structural planning is a mixture of basic knowledge with the art of science in structural analysis, statics, mechanics of materials, and dynamics to obtain structures that are safe and economical in their service life the structure must be able to bear earthquake loads based on its coefficient ratio and ensure the building does not experience structural collapse and failure due to earthquake loads in the study area with the design load to be accepted (Maysarah, Yulina Ismida).

The purpose of this study was to plan the dimensions of the building's portal structure that can withstand loads safely. This research was conducted in Karang Asem 1, Kuningan, Setia Budi, South Jakarta.

In order to focus on appropriate structural research, this research is limited; concrete quality f'c = 25 MPa, floor plate 120 mm, planning only on the calculation of the column and beam structure, longitudinal reinforcing steel fy = 420 MPa and reinforcing steel fy = 280 Mpa, the type of soil based on the results of soil penetration resistance is soft soil (SE).

II. LITERATURE REVIEW

The separation between static and dynamic loads is fundamental in the load analysis stage for the design of high-rise buildings. The concept of this separation is intended to facilitate the grouping of its relationship with the load combination for the next stage of analysis.

a. Dead load

Dead load is the weight of all parts of a building that are permanent, including all additional elements, finishes, machinery and equipment that are an integral part of the building.

b. Live load

The live load on the floor of the building shall be taken according to table 1. The live load includes space equipment in accordance with the use of the floor of the room in question, as well as lightweight dividing walls with a weight of not more than 100 kg/m2. Heavy loads, for example those caused by file cabinets and libraries as well as tools, machines and certain other items that are very heavy, must be determined separately.

Table 1. Live load

Occupany or use	Equally psf (KN/m^2)	Centered lb (KN)
Office room	50 (2.4)	2000 (8.9)
Meeting room Lobby	100 (4,79)*	-
Balcony and deck	1,5 times the live load for the area served. No	-

Occupany or use	Equally psf (KN/m^2)	Centered lb (KN)
	need to exceed 100 psf (4,79 KN/m^2)	
Corridor First floor Another floor	100 (4,79) Same ar residential service unless otherwise stated.	-
Dining room and restaurant	100 (4,79)*	-
Library Reading room Storage space The corridor above the first floor	60 (2,87) 150 (7,18) 80 (3,83)	1000 (4,45) 1000 (4,45) 1000 (4,45)
Swimming pool	100 (4,79)	-
Residential housing (one family and two families)	10 (0,48)	-
All other residential dwellings Private spaces and corridors that serve them	40 (1,92)	-
Public spaces and corridors that serve them	100 (4,79)	

(Sumber: SNI 1727:2020)

Structural members having a KLL A_T value of 400 ft^2 (37.16 m^2) or more are permitted to be designed with reduced live loads according to the following formula:

$$L = L_o\left(0,25 + \frac{4,57}{\sqrt{Kll\ At}}\right) \quad \text{.......... (1)}$$

c. Wind load

The design wind pressure for the main wind resisting system (SPGAU) of a building at all heights in lb/ft^2 (N/m^2) shall be determined by the following equation:

$$p = qGC_p - q_i(GC_{pi}) \quad \text{..................... (2)}$$

where:

p = Design wind pressure (N/m^2);
q = incoming wind wall velocity pressure (qz) measured at a height z, or other wall/roof velocity pressure (qh) measured at a height h (N/m^2);
qi = pressure velocity to evaluate the positive/negative internal pressure on all surfaces conservatively taken as (qh) measured at a height h (N/m^2);
G = wind gust effect factor;
Cp = coefficient of external pressure;
(GCpi) = coefficient of internal pressure.

d. Earthquake load

Earthquake loads are all equivalent static loads acting on structures due to ground movement caused by earthquakes moving vertically or horizontally.
This study follows the guidelines of SNI 1726:2019.

III. METHODS

a. Research site

This building plan is located in Karang Asem 1, Kuningan, Setia Budi, South Jakarta. With latitude 6o13'35.89" S and longitude 106o49'53.04" T.

Figure 1. Coordinates
(Source: Google Earth, 2021)

b. Overview of the building structure

This building structure is built with 3 floors equipped with a roof and a basement with a building area of 447.2375 m2. The type of construction used is reinforced concrete with a non-concrete roof structure. The interesting thing about this building is that there is a swimming pool with an area of 66 m2 on the 3rd floor and there is a sliding wall in the basement area. This structure uses f'c 25 MPa with the modulus of elasticity of concrete (E) is 23,500 MPa. The main reinforcement quality used is fy 420 MPa and Fu 525 MPa. Meanwhile, the quality of stirrup reinforcement used is fy 280 MPa and Fu 350 MPa.

The floor plan of this research building can be seen in the image below, among others:

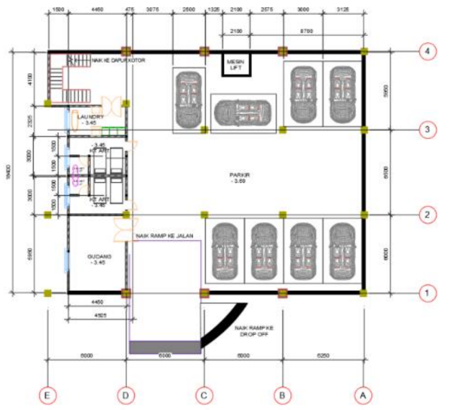

Figure 2. Floor Plan

Figure 3. Floor Plan 1

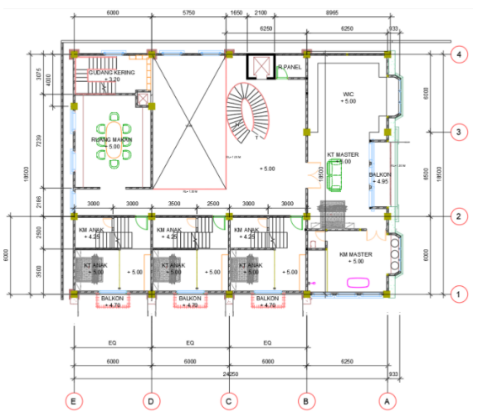

Figure 4. Floor Plan 2

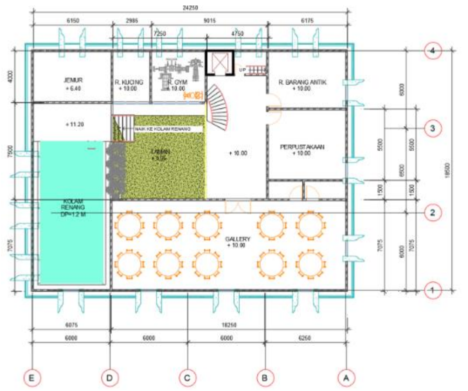

Figure 5. Floor Plan 3

c. Planning guide

In planning, the guidelines used include:

1. Requirements for reinforced concrete for buildings and explanations (SNI 2847:2019)
2. Minimum load for designing buildings and other structures (SNI 1727:2020).
3. Procedures for designing earthquake resistance for building and non-building structures (SNI 1726:2019)
4. Specifications for structural steel buildings (SNI 1729:2020)
5. Concrete reinforcement steel (SNI 2052:2017)

d. Loading

Dead Load is the weight of a building that is fixed, which is an additional element, fixed machinery and equipment including an integral part of the building structure (SNI 1727:2020).

Table 2. Superdead load

Beams / Floor Slabs	Height / width (m)	Heavy (KN/m^3)	amount (KN/m^2)
Wall	5	2,5	12,5
The amount of additional dead load on the beam			12,5
MEP installation			0,25
Ceramic	1	0,24	0,24
Sand	0,05	16	0,80
Space	0,03	22	0,66
Ceiling + frame			0,20
The amount of additional dead load on the floor slabs			2,15
Ceramic	1	0,24	0,24
Sand	0,05	16	0,80
Space	0,03	22	0,66
The amount of additional dead load on the elevation +11,20			1,70

Live load is the load of room equipment in accordance with the use of the floor in each room concerned. The live load used in this plan is taken in accordance with table 1 regarding the minimum evenly distributed live load and minimum concentrated live load (SNI 1727:2020).

e. Earthquake resistance planning

The priority factor for earthquake and the category of building structure in this plan

includes housing with a risk category of 2 so that the priority factor for earthquakes is 1.
The response spectra parameters used are based on the Indonesia 2021 spectral design. From these parameters, the SS MCER data is 0.8115 g and S1 is 0.3921 g with the seismic design category based on SDS = 0.6767 and the risk category II is category D. While the seismic design category is based on SD1 = 0.6356 and risk category II then obtained the same category (D). so that based on the table of factors R, Cd, and 0 for the seismic force bearing system, we get a special moment resisting reinforced concrete frame with a response modification coefficient (R) 8, a system strength factor (Ω0) 2,5 and a deflection amplification coefficient (Cd) 5.5.

f. Roof load

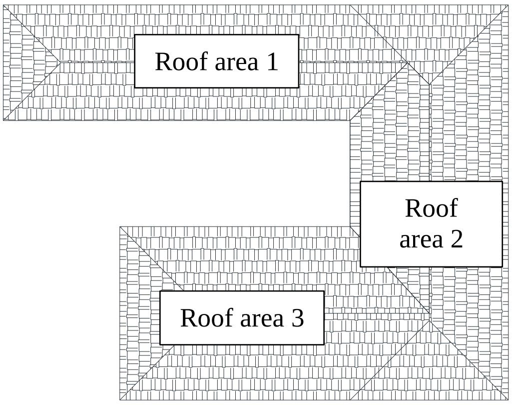

Figure 6. 3D modeling ETABS

Metal roof coveringload	= 10 kg/m2
Roof truss load	= 12 kg/m2
	= 22 kg/m2

Roof area 1 = 120,00 m^2
Roof area 2 = 144,375 m^2
Roof area 3 = 112,00 m^2

Design and analyze using ETABS v.19.0

The design of the frame structure model with etabs goes throught the following stages:

a. Determine the geometry of the structure model

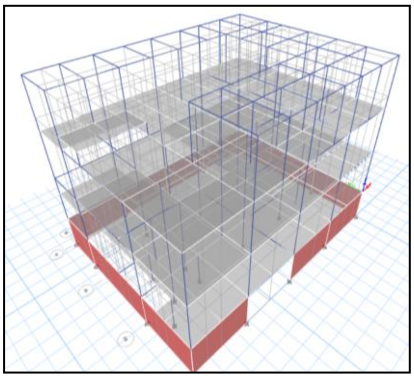
Figure 7. 3D modeling ETABS

b. define the data according to the research to be made.
c. Assign data that has been defined into the modeling structure.
d. Check the data that has been input again
e. Design of concrete and steel structures according to existing regulations.
f. Re-design of the building structure.
g. Structural analysis or Run Analysis

IV. RESULTS AND DISCUSSION

a. Column calculation

The columns must meet:
The smallest cross-sectional dimension, measured on a straight line through the center of the geometry, is not less than 300 mm.
The ratio of the smallest cross-sectional dimensions to the perpendicular dimensions is not less than 0.4.
The flexural strength of the column must satisfy the following equation:

Mnc (1,2) Mnb ……………………………. (1)

Where:

Mnc = Total nominal flexural strength of the column framing into the joint;
Mnb = Total nominal flexural strength of the beam framing into the joint.

b. Calculation of beams

SRPMK beam (special moment resisting frame system) is a part of seismic force resisting system which is mainly designed to resist shear and bending. Each frame member subjected to factored axial compression must be less than (Ag f'c / 10).
The value of 1 for the equivalent square concrete stress distribution is determined in table 3.

Table 3. β_1 equivalent square concrete stress

F'c (MPa)	β_1	
$17 \leq f'c \leq 28$	0,85	a)
$28 < f'c < 55$	$0{,}85 - \dfrac{0{,}05\,(f'c - 28)}{7}$	b)
$f'c \geq 55$	0,65	c)

The recapitulation of beam and column reinforcement calculations is presented in table 4 including:

Table 4. Recapitulation of beam and column reinforcement

No	Description	Area	Long. reinforcement (mm)	Stirrup (mm)
1	Balok 450/600	Focus	18 D 16	3d10-100
		Field	13 D 16	3d10-120
2	Balok 450/700	Focus	15 D 16	2d10-100
		Field	11 D 16	2d10-100
3	Balok 500/700	Focus	15 D 16	2d10-100
		Field	11 D 16	2d10-110
4	Balok 550/700	Focus	14 D 16	2d10-100
		Field	11 D 16	2d10-110
5	Balok 600/750	Focus	13 D 16	2d10-100
		Field	10 D 16	2d10-150
6	balok induk 450/650	Focus	16 D 16	3d10-100
		Field	12 D 16	3d10-130
7	balok anak 400/550	Focus	4 D16	2d10-50
		Field	4 D16	2d10-200
8	Ring balok 250/400	Focus	2 D14	2d10-100
		Field	2 D14	2d10-200
9	Kolom 400/350		14 D 14	2d10-100
10	Kolom 400/400		20 D 16	2d10-100
11	Kolom 450/450		22 D 16	2d10-100
12	Kolom 500/450		22 D 16	2d10-100
13	Kolom 650/650		24 D 22	3d10-50

From the results of the above table recapitulation, several pictures of beam and column reinforcement are obtained.

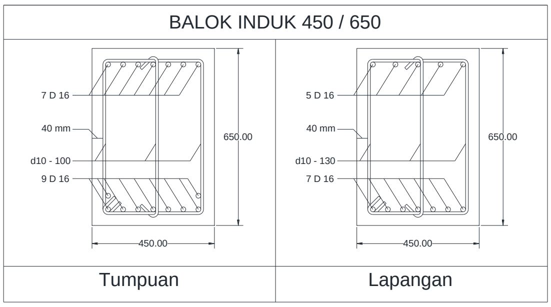

Figure 8. Reinforcement of beams in AutoCAD

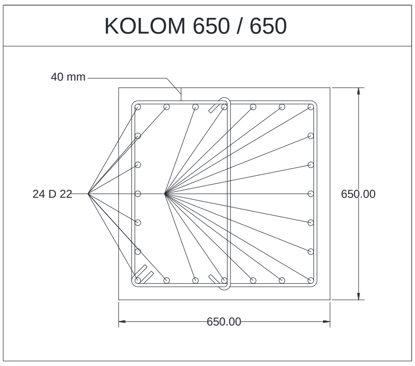

Figure 9. Reinforcement of 650/650 columns in AutoCAD

V. CONCLUSION

In calculating the building structure research that has been carried out, it can be concluded that there are several beams used including, 450/600 beams, 450/700 beams, 500/700 beams, 550/700 beams, 600/750 beams, 450/650 beams, child beams 400/550, and beam rings. All the beams mentioned above use D16 longitudinal reinforcement with d10 stirrup reinforcement. while the columns used are 400/350 columns, 400/400 columns, 450/450 columns and 450/500 columns using D16 longitudinal reinforcement with d10 stirrup reinforcement. And the 650/650 column uses D22 for longitudinal reinforcement and d10 for stirrup reinforcement.

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