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Structure Review of Periodic Columns Becoming Round Columns with SAP 2000 v.22 On A Six Lane Office in Balaraja

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A B S T R A C T

In the implementation of a building construction there are often failures due to damage that occurs to the structure or parts of the structure during the implementation stage or after completion. In general, a building structure planning for office buildings, schools, hospitals, or residential houses uses a square column design as a barrier to the construction above it. In contrast to round columns, it is very rare to find the use of round columns as the main column of a multi-storey building structure. In addition to aesthetics, there is a fundamental difference between the design of square columns and round columns, where round columns are more efficient in distributing compressive forces so that they are able to withstand loads and vibrations due to earthquake loads better due to a more even distribution of forces than square columns. In addition, in tall buildings, round columns are more aerodynamic than square columns, minimizing the resistance and load generated by the wind itself. Various kinds of computer applications are used in structural planning, namely by using the BIM application, Etabs and other applications. However, in this study, it still uses SAP 2000 v22.This research method uses quantitative methods. Suppose building data, materials and soil. Based on the results of the analysis and calculations carried out on the Re-planning of Office Reinforced Concrete Structures in Balaraja into Round Columns, it can be concluded

INTRODUCTION

Office building is a place to carry out economic activities. The main work in the office is in information handling activities and management activities and decision making based on this information. This will result in variations in office size based on management, organizational structure and technology. Therefore, in planning office buildings, careful planning is needed in terms of security, cost, usability, shape, architecture, structure, and available services.1

In the implementation of a building construction there are often failures due to damage that occurs to the structure or parts of the structure during the implementation stage or after completion. This event is caused, among others, by factors that were not previously taken into account, such as errors in planning and implementation as well as load overload due to changes in the function of the building. In planning a building structure is usually preceded by making several assumptions such as the magnitude of the forces acting and the quality of the materials to be used which in the end the planning cycle must be tested.2

Various kinds of use of computer applications in structural planning, namely by using BIM applications, Etabs and other applications that are very beneficial for engineers, for example, can make work relatively easier. which currently tends to be more widely used in the calculation of internal forces in building structures .3

With the existence of various applications used in structural calculations in multi-storey buildings, including BIM (Building Information Modeling) and Staad Pro.

(BIM) is the process of using integrated digital models to visualize and manage information related to the design, construction, and management of a building. BIM models include aspects such as building geometry, spatial data, component information, time, and cost. Using BIM, construction professionals can work collaboratively, integrate data from multiple sources, and analyze the impact of design decisions before starting physical construction. Staad Pro is a structural analysis design software that allows users to analyze and design building structures. Staad Pro has a user- friendly interface, 3D design features and actual material references. However, in this research, it still uses SAP 2000 v22.

LITERATURE REVIEW

Various kinds of columns are used with different dimensions according to the function of the building and the load carried. In general, a building structure planning for office buildings, schools, hospitals, or residential houses uses a square column design as a barrier to the construction above it. In contrast to round columns, it is very rare to find the use of round columns as the main column of a multi-storey building structure.

As with the office building located on Jalan Kota Balaraja, the column structure used is a square column structure with dimensions of 90 x 90 cm consisting of 6 floors.

In addition to aesthetics, there is a fundamental difference in the design of square columns and round columns, where round columns are more efficient in distributing compressive forces so that they can withstand loads and vibrations

due to earthquake loads better due to a more even distribution of forces than square columns. In addition, in tall buildings, round columns are more aerodynamic than square columns so as to minimize the resistance and load generated by the wind itself. Based on the description above, a study was taken with the title "Re-planning of Office Reinforced Concrete Structures in Balaraja into Round Columns", to find out how the effectiveness of a structure using round columns in terms of strength, stiffness and efficiency of the structure itself.

METHODOLOGY

Planning Location

This research location is on Jalan Raya Serang KM 24.5 Kp Kosambi RT 01/03 Balaraja, Tangerang Banten. The author chose this research location based on several considerations such as, the number of building floors, strategic infrastructure in reaching information, data collection and budget efficiency.

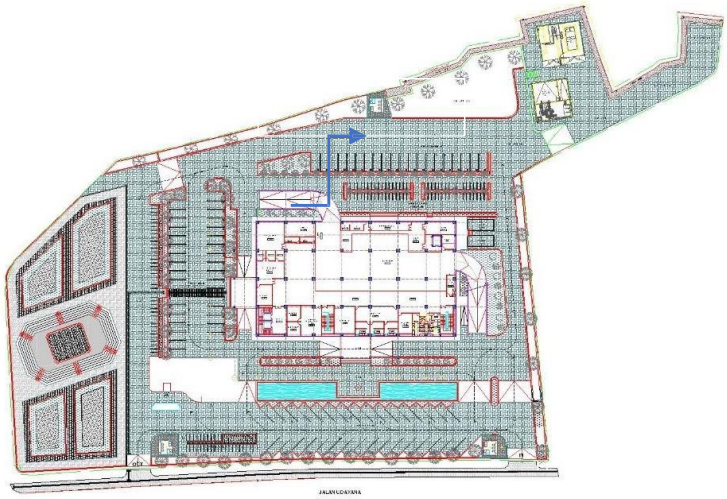

Figure 1. Site Plan of Building in Balaraja
Source: (PT. TIARINDO, 2024)

Planning Data

General Data General Building Data

- Building name : Building
- Location : Raya Serang KM 24.5 Kp Kosambi RT 01 / 03 Balaraja, Tangerang, Banten.
- Function : Office
- Number of Floors: 5 Floors, 1 Semi Basement and 1 rooftop
- Floor Height Basement Floor: 3.9 meters 420) while for plain reinforcing steel fy = 280 Mpa (BjTP 280).5
- 1st floor : 4.5 meters
- 2nd Floor : 5.1 meters
- 3rd floor : 4.5 meters
- 4th Floor : 4.5 meters
- 5th floor : 4.5 meters Rooftop

- Column size Basement floor -Floor 2: 0.90 x 0.90 m
  3rd floor - 5th floor: 0.80 x 0.80 m
- Building Length : 56 m
- Building Width : 32 m
- Building Height : 27 m
- Main Structure : Reinforced Concrete Structure

2. Building Data

In the form of column plans, beams, plates and reinforcement details in autocad format.

3. Material Data

a. Concrete Quality

Concrete specifications used for columns, beams, floor plates and other reinforced concrete structures are using concrete with a compressive strength off 'c = 25 Mpa in accordance with the Work Plan and Conditions listed.

b. Reinforcing Steel Grade

The reinforcement specifications used in the construction of the Balaraja office building are threaded reinforcementfy = 420 Mpa (BjTD.

4. Land Data

Soil data obtained from the land location of the Balaraja office building can be seen in Figure 2 below:

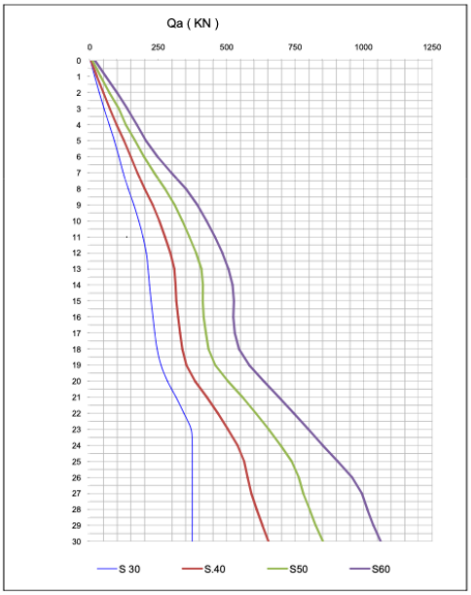

Figure 2. Land Data
Source: (PT. TIARINDO, 2024)

5. Flow Chart Planning

The research method can be seen in Figure 3 below:

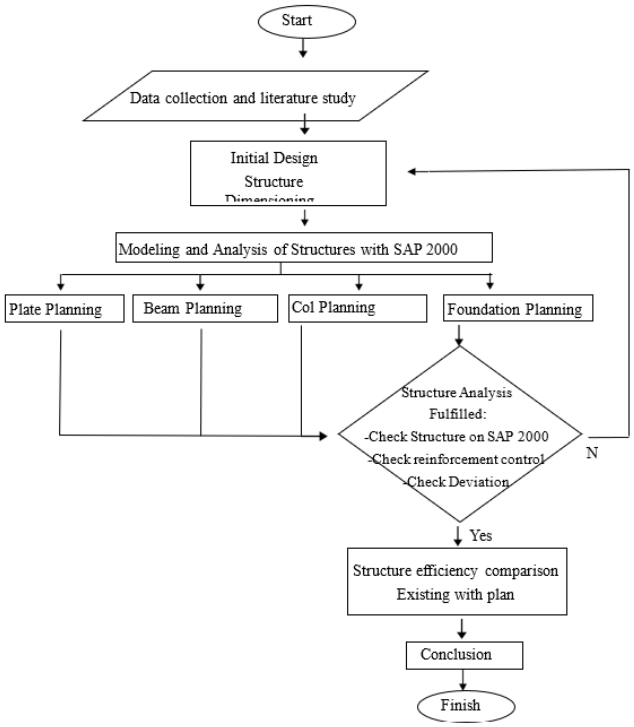

Figure 3. Flow Chart Planning

RESEARCH AND DISCUSSION

1. General

Analysis of the calculation of the Balaraja Office Building Structure using SAP2000 V.22 software with predetermined planning input data. The results of the analysis in the form of force data in the structure and maximum displacement that can be used as data in the calculation of the building structure of the Balaraja Office Building Structure using round columns.6

2. Existing Design

The initial structural design data of the Balaraja Office Building Structure in the form of plate plans, beam plans, column plans, reinforcement details and other design data can be seen in the appendix.7

3. Structure Material

The structure of the Balaraja Office Building is designed using material data with material quality and requirements in accordance with regulatory standards that have been determined as follows:8

4. Dimensions of Structural Elements

1. Floor Plate

The thickness of the existing floor plate on the Balaraja Office Building Structure is 150 mm, and in this planning the plate thickness used is 120 mm.

2. Beam Dimensions

The dimensions of the existing beams and redesigned beams on the Balaraja Office Building Structure building can be seen in Table 4.1. below.

Table 1. Beam Dimensions

Existing Beams				Beam *Redesign*		
No	**Beam Code**	**Span /L (m)**	**Dimensions (mm)**	**Beam Code**	**Span /L (m)**	**Dimensions (mm)**
1	B1	8,00	350 x 700	B1	8,00	300 x 600
2	B2	8,00	350 x 700	B2	8,00	300 x 600

(Source: Muh. Zulyadaen / Personal, 2024)

3. Column Dimension

The column dimensions of the Balaraja Office Structure building can be seen in Table 2 below.

Table 2. Column Dimension

0	**Code**	**Dimensions (mm)**	**Code**	**Dimensions (mm)**
1	K1	900 x 900	K1 R	Diameter 900
2	K1 a	800 x 800	K1 a R	Diameter 800

5. Loading

In the construction of office buildings, the loading standards used are:

1. SNI 1726:2019 "Earthquake Resistance Planning Procedures for Building and Non- Building Structures".
2. SNI 2847:2019 "Structural Concrete
3. SNI 1727:2020 "Minimum Design Loads and Related Criteria for Buildings and Other Structures".
4. Indonesian Loading Regulations for Buildings (PPIUG 1983).

1. Dead Load Calculation

The loading calculation carried out to find out how much load will be received by the Balaraja Office Building Structure.[9]

a. Dead Load on Slab

- Weight of 1 cm thick ceramic = 0,01 x 24 = 0.24 kN/m²
- Weight of 3 cm thick specimen = 0,05 x 22 = 1.05 kN/m²
- ME Installation = 0,25 = 0.25 kN/m²
- Ceiling = 0,11 = 0.11 kN/m²
- Hanger = 0,07 = 0.07 kN/m²
- Qd = 1.29 floor slab kN/m²

b. Dead Load on Structure Beams

The architectural wall specification is ½ red brick masonry with a weight of 2.5 kN/m2, while the loading on the beam is loaded by the wall as follows:

1. 1st Floor (4.5 meters high)
   - Weight of ½ brick wall : 4,5 x 2,5 = 11.25 kN/m
2. 2nd Floor (5.1 meters high)
   - Weight of light brick wall : 5,1 x 2,5 = 12.75 kN/m
3. Floors 3-5 (4.5 meters high)
   - Weight of light brick wall : 4,5 x 2,5 = 11.25 kN/m
4. Roof floor (3 meters high)
   -Weight of ½ brick wall : 3 x 2,5 = 7.5 kSNa/nmdra

2. Live Load Calculation10

Based on PPPURG 1987 where the building functions as an office, the live load on the floor is as follows:

a. For basement floors up to 5
   - Working live load of 250 kg/m2 = 2.5 kN/m2

b. For the 6th floor (roof)
   - Working live load of 100 kg/m2 = 1.0 kN/m2

3. Earthquake Load Calculation

In calculating the response range of the Balaraja Office Building structure, it must first determine the response parameters that are suitable for the location of the building. Analysis of structures against earthquake loads refers to SNI 1726-2019.

a. Earthquake response acceleration parameter earthquake coefficient [11]

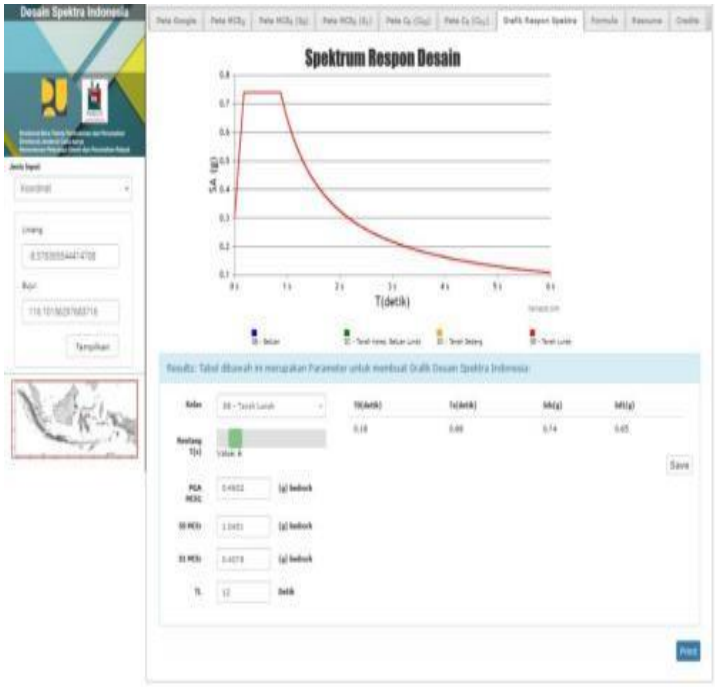

Figure 4. Spektra Indonesia Design for Building Balaraja Office Building Structure Source: (https://rsa.ciptakarya.pu.go.id/2024/)

6. Floor Plate Planning

As for the results of the calculation of X- direction field reinforcement, calculation of Y- direction field reinforcement, calculation of X- direction pedestal reinforcement and calculation of Y-direction pedestal reinforcement can be seen in Table 4.6 .

7. Beam Planning

For the results of the recapitulation of beam reinforcement planning calculations on codes B1, B2 and can be seen in Table 4.7.

8. Column Planning

As for the recapitulation of the results of the calculation of column reinforcement planning K1 and K1 A can be seen in Table 4.8.

9. Comparison of Square Column Structure (Existing) with Round Column Structure

(Redesign)

1. **Comparison of Reinforcement Area12**

   Comparison of reinforcement area on square column structure (existing) with round column structure (redesign) can be seen in Table 4.14. Based on the difference in the reinforcement area of the square column structure (existing) with the round column structure (redesign) obtained of 6,150.126 mm² or with a total percentage of 14.518%, it can be concluded that the redesign carried out using SAP2000 V.22 software on the Balaraja Office Building Structure is more efficient.

2. **Concrete Volume Ratio13**

   Based on the difference in concrete volume obtained of 256.945 m3 or with a total percentage of 21.718%, it can be concluded that the redesign

carried out using SAP2000 V.22 software on the Balaraja Office Building Structure is more efficient.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis and calculations carried out on the Re-planning of the Office Reinforced Concrete Structure in Balaraja into Round Columns, it can be concluded as follows:

1. How to design an office building in balaraja with round columns, that is:
   a. Dimensioning structural elements such as plates, beams, columns and foundations
   b. Statics calculations in the form of dead loads, live loads and earthquake loads on each structural element.
   c. Reinforcement calculations of structural elements are plate, beam, column and foundation reinforcement.
   d. Detailed depiction of structural elements.
2. The dimensions and amount of reinforcement used in the office structure in Balaraja with round columns are as follows:
   a. The floor slab is 120 mm thick with x- direction reinforcement of D10-225 mm and y-direction reinforcement of D10-240 mm.
   b. Transverse (B1) and longitudinal (B2) beams use dimensions of 30 x 60 cm with reinforcement in the support area of 14 D22 with D10-200 mm stirrups. while in the field area using 5 D22 tulanagan with D10-300 stirrups.
   c. The basement to 2nd floor column (K1) uses dimension 900 with 25 D25 reinforcement and D10-300 mm stirrups. while for the 3rd floor to roof column (K1 A) uses dimension 800 with 18 D25 reinforcement and D10-300 mm stirrups.
   d. The bore pile type foundation has a diameter of 0.5 m at a depth of 22 m with a main reinforcement of 5 D16 and a stirrup 10 -350 mm. while the pilecap has dimensions of 2.5 x2.5 x 1.2 m, with x- direction reinforcement of D22-70 mm and y-direction reinforcement of D22-100 mm.
3. Comparison of structural efficiency in terms of reinforcement area and concrete volume using square column structure with round column structure at the office in Balaraja as follows:
   a. Based on the difference in the reinforcement area of the square column structure (existing) with the round column structure (redesign) obtained of 6,150.126 mm^2 or with a total percentage of 14.518%, it can be concluded that the redesign carried out using SAP2000 V.22 software on the Office building structure in Balaraja is more efficient.
   b. Based on the difference in concrete volume obtained of 256.945 m 3 or with a total percentage of 21.718%, it can be concluded that the redesign carried out using SAP2000 V.22 software on the Office building structure in Balaraja is more efficient.

Advic

1. For further research, it is expected to compare between round columns and square columns in different plans and locations, to get to know more about the structural response and strength of structural elements, especially columns.
2. For further research, it is expected to continue the comparative analysis of the estimated cost budget plan (RAB) based on the comparison of square columns and round columns.

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