ANALYSIS STRUCTURE THE PT. TEMPO LAND BUILDING

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ABSTRACT

Mundu is an area in the district of Cirebon that passed by the Pantura lane, in the area of the Mundu there are various kinds of trading industry, one of which is the trading industry from PT. TEMPO LAND that are producing medicines for health. In order to create a good production and marketing, so in the area is built office production and marketing of PT. TEMPO LAND.

PT. TEMPO LAND is a group company in the form of by the TEMPO GROUP or PT. TEMPO SCAN PACIFIC Tbk. The company PT. TEMPO GROUP started its business on November 3, 1953. Production from this company produces a variety of pharmaceutical and healthcare products with different brands.

In order to create a structure that is safe and meets serviceability limit, so in the process of design the building structure must be according to SNI - 2847 - 2013 of reinforced concrete, which is the latest regulations adapted from the latest material technology development refers to the AISC. Beside planning, the loading structure must be according to SNI – 1727 – 2013 , then for calculation of earthquake engineering refers to SNI – 1726 – 2012.

Analysis structure using SAP2000, for the material of structures is used concrete including frame section (column, sloof, beam, and slab). And then the result from analysis are the PT. TEMPO LAND building is safe or not, with check the deflection and check load maximum permit from analysis foundation of PT. TEMPO LAND.

Keywords: Analysis structure, SAP2000, frame section, deflection.
A. BACKGROUND

Cirebon is a city that quite rapidly progress in the field of tourism, economy, and services. The one factor that dominates development the Cirebon city is the economy, a wide variety field of the economy competition for example like trading industry.

Cirebon city itself has a very strategic geographical location, besides of Cirebon city is also a city track that connects West Java and Central Java, this condition potentially attracting tourists to visit the Cirebon city, causing the trade industry competition is very strict.

Mundu is an area in the district of Cirebon that passed by the Pantura lane, in the area of the Mundu there are various kinds of trading industry, one of which is the trading industry from PT. TEMPO LAND producing medicines for health. In order to create a good production and marketing, so in the area is built office production and marketing of the PT. TEMPO LAND.

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In order to create a structure that is safe and meets serviceability limit, so in the process of design the building structure must be according to SNI - 2847 - 2013 of reinforced concrete, which is the latest regulations adapted from the latest material technology development refers to the AISC.

Beside planning, the loading structure must be according to SNI – 1727 – 2013 then for calculation of earthquake engineering refers to SNI – 1726 – 2012.

B. PROBLEM FORMULATION AND PROBLEM IDENTIFICATION

1. Problem Formulation
   b. Do not design Retaining Wall, ME and Plumbing.
   d. Calculate the budget structure.

2. Problem Identification
   Based on the description formulation of the problem, so the problem can be identified as follows:
   a. How to design the structure PT. TEMPO LAND building according with the regulations of SNI?
   b. How to design the dimension of Slab, Beam, Column, and Foundation?
   c. How seismic force that occur in the structure PT. TEMPO LAND building?
   d. How to calculate the budget structure of PT. TEMPO LAND building?

C. RESEARCH PURPOSE

1. Design frame section with SAP2000 including Slab, Beam Column and Foundation of the PT. TEMPO LAND building.
3. Calculate the budget of the structure.
D. FRAMEWORK THINKING

Framework thinking of this thesis use qualitative research methods, its conducting data collection. The collection data was obtained by way as follows:
1. References and study literature
2. Data obtained from the agencies
3. Field Observation
4. Browsing the Internet.

A. BASIS THEORY OF ANALYSIS STRUCTURE

1. Structural Portal System

Portal structure is the structure formed of elements of a straight stem, generally composed of beams and columns with the connection between the ends of the stem are assumed to be "stiff perfect" in order to prevent rotation of the relative rotation between the structural elements relate.

![Figure 2.1 System structural](image)

2. Loading System of The Structure

Load operation system for multistory building structural elements can generally be expressed as: load slab are distributed to the joist and beam portal, portal beam load distributed to load the column and the column is then forwarded to the sub-grade through the foundation.

For example, Figure in the below shows the distribution pattern of the slab load beam, the beam span of D-C to bear the burden on the span trapezoidal beams bear the burden of 5-6-7 triangle.

![Figure 2.2 Loading system](image)
3. Structural Behavior

Portal structure consists of beams and columns, which have a rigid connection, if will be burdened load will arise deflection and forces (moments, shear, normal). For more details about changes to the structure of the portal due to the load can be seen in Figure 2.3.

![Figure 2.3 Structural behavior](image1)

B. MODELING STRUCTURE SAP2000

1. System Coordinate SAP2000

SAP2000, Structural Analysis Program, is one program civil engineering applications for structural analysis and design on a wide variety of buildings.

Analysis of the structure is meant is looking for any response to the loading a given structure, it is form of internal forces of structural elements or forces of reaction placement, as well as deformation (deflection) of the structure itself.

The coordinate system used is a square three-dimensional coordinate system (Cartesian) which refers to the right-hand rule. With the right hand (thumb, index and middle fingers) to form a line perpendicular to one another, and the direction indicated by the three right hand fingers shows the positive direction of the axis coordinate system. Where thumb as the X-axis, Y-axis and your index finger as middle as the Z axis.

![Figure 2.4 Coordinate system](image2)

2. Modeling the Structure

The initial stage before to do analysis of the structure is to create a model structure, structural modeling is numeric data generation (mathematical) represents the real structure used as computer data input.

On the program SAP2000 provided some of the structural model by default, see Figure 2.5 The model of this structure can be modified or create a new model that is in accordance with planning.

![Figure 2.5 Modeling structure](image3)

3. Material and Section Properties

At SAP 2000 are available various types of structural materials include concrete, steel and aluminum. Various types of materials can be applied to any element that has been modeled. In determining the property, the initial parameters relating to material that can be modified according to Planning for or standards used. Likewise, the section material.
4. Loads

A structure requires a review on the various loading conditions. It is generally in the section design process to find critical condition. In this case, the need to load grouping that has the same type. For example a group of dead load (self weight, walls) or live load (load workers) or lateral loads (wind, earthquake). The group within the meaning of expressed by Static Load analyzed separately from each other.

A. OBJECT AND RESEARCH METHOD

1. Research Location

The research location of office PT. TEMPO LAND building, on Jl. Mundu Pesisir No. 35 Cirebon.

![Figure 2.8 Project Location](image)

2. Time Research

The time research, begin on March 12th 2016 until June 12th at the time of practical work, the activity done are survey and collecting the data.

The thesis preparation begins on November 8th 2016 until April 8th 2017, which predicted during five months.

B. TYPE METHOD AND SOURCE OF DATA.

Based on the origin, the data are grouped to be two data, as follows:

1. Primary Data

Primary data are the data obtained from survey and direct observation to the location or object research.

2. Secondary Data

Secondary data is data obtained from references, books and the internet related to the building design.

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

1. 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.
2. The observation method are the method obtained from the survey directly, to the location or object research. With the survey to location of research, it can be seen and obtained data on the structural design of buildings PT. TEMPO LAND building.

A. ANALYSIS AND DISCUSSION

1. Analysis Structure Data

Building Specification
a. Building function : Building office
b. Building area 1504,80 m²
c. Building height : 14,00 m (including dak roof)
d. Building Configuration :

<table>
<thead>
<tr>
<th>No.</th>
<th>Building</th>
<th>Elevation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basement</td>
<td>-3.00</td>
</tr>
<tr>
<td>2</td>
<td>1st floor</td>
<td>+0.00</td>
</tr>
<tr>
<td>3</td>
<td>2nd floor</td>
<td>+3.00</td>
</tr>
<tr>
<td>4</td>
<td>3rd floor</td>
<td>+6.00</td>
</tr>
<tr>
<td>5</td>
<td>4th floor</td>
<td>+10.00</td>
</tr>
<tr>
<td>6</td>
<td>Roof</td>
<td>+14.00</td>
</tr>
</tbody>
</table>

2. Material Specification
a. Concrete : K-250, $f_c = 21$ Mpa
b. Rebar :
   - D19 (BJTD40), $f_y = 400$ Mpa
   - Ø10 (BJTP24), $f_y = 240$ Mpa

c. Sloof (Tie beam) :

<table>
<thead>
<tr>
<th>No.</th>
<th>Type Sloof</th>
<th>Dimension (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sa</td>
<td>45/25</td>
</tr>
<tr>
<td>2</td>
<td>S2</td>
<td>50/30</td>
</tr>
<tr>
<td>3</td>
<td>S1</td>
<td>50/30</td>
</tr>
</tbody>
</table>

d. Beam

<table>
<thead>
<tr>
<th>No.</th>
<th>Type Beam</th>
<th>Dimension (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ba</td>
<td>45/25</td>
</tr>
<tr>
<td>2</td>
<td>B2</td>
<td>50/30</td>
</tr>
<tr>
<td>3</td>
<td>B1</td>
<td>50/30</td>
</tr>
</tbody>
</table>

d. Column

<table>
<thead>
<tr>
<th>No.</th>
<th>Type Column</th>
<th>Dimension (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>K1</td>
<td>55/55</td>
</tr>
<tr>
<td>2</td>
<td>K2</td>
<td>50/50</td>
</tr>
<tr>
<td>3</td>
<td>K3</td>
<td>40/40</td>
</tr>
</tbody>
</table>

B. ANALYSIS STRUCTURE

1. Model Structure

![Figure 4.22 Model structure](PT-TEMPO-LAND-Image)

2. Define Materials (Concrete and Rebar)

- Material used are concrete, longitudinal reinforcing (deform) and transversal reinforcing (shear). And then for section
property are sloof (tie beam), beam, column and slab.
Define materials concrete, rebar, and specification are as follow:

a. Concrete:
   Weight unit per volume
   
   (2400 Kg/m³) = 2.4.10⁻⁵ N/mm³
   Concrete Quality f<sub>c</sub> = 21 Mpa
   E<sub>c</sub> = 4700*f<sub>c</sub>¹/² = 21538,106 Mpa
   (N/mm)
   Poisson ratio = 0,2

b. Longitudinal rebar (deform):
   Weight unit per volume
   (7850 Kg/m³) = 7,850.10⁻⁵ N/mm³
   Yield Stress, f<sub>y</sub> = 400 Mpa (N/mm)
   E<sub>s</sub> = 200.000 Mpa (N/mm)
   Poisson ratio = 0,3

c. Transversal rebar (shear):
   Weight unit per volume
   (7850 Kg/m³) = 7,850.10⁻⁵ N/mm³
   Yield Stress, f<sub>y</sub> = 240 Mpa (N/mm)
   E<sub>s</sub> = 200.000 Mpa (N/mm)
   Poisson ratio = 0,3

To make it easily data input, then used the unit N, mm, C because the unit Mpa is equal to N/ mm.

3. Define Section Properties

   After define the material, the next steps are define and design frame section (sloof, beam, column and slab), frame section was define, must be same with the data from PT. TEMPO LAND:

a. Sloof
   Sa, 45 x 25 cm
   S1, 50 x 30 cm
   S2, 50 x 30 cm

b. Beam
   Ba, 45 x 25 cm
   B1, 50 x 30 cm
   B2, 50 x 30 cm
c. Column
K1 55 x 55 cm
K2 50 x 50 cm
K3 40 x 40 cm
d. Slab
Basement slab, h = 15 cm
Slab 1st – 4th, h = 12.5 cm
Dak roof, h = 10 cm

Analysis Structure The PT. TEMPO LAND Building

The additional dead load inputted to slab, without added with "density concrete" (weight unit per volume of concrete 24 kN/m³) are as follow:

<table>
<thead>
<tr>
<th>No</th>
<th>Jenis Beban Mati</th>
<th>Berat satuan</th>
<th>Tebal (m)</th>
<th>Q (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Berat finishing lantai</td>
<td>22.0</td>
<td>0.05</td>
<td>1.100</td>
</tr>
<tr>
<td>2</td>
<td>Berat instalasi ME</td>
<td>0.5</td>
<td>-</td>
<td>0.500</td>
</tr>
<tr>
<td>Σ</td>
<td></td>
<td></td>
<td></td>
<td>1.600</td>
</tr>
</tbody>
</table>

Slab 1st – 4th = 1.8 kN/m²

<table>
<thead>
<tr>
<th>No</th>
<th>Jenis Beban Mati</th>
<th>Berat satuan</th>
<th>Tebal (m)</th>
<th>Q (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Berat finishing lantai</td>
<td>22.0</td>
<td>0.05</td>
<td>1.100</td>
</tr>
<tr>
<td>2</td>
<td>Berat instalasi ME</td>
<td>0.5</td>
<td>-</td>
<td>0.500</td>
</tr>
<tr>
<td>3</td>
<td>Berat plafon dan rangka</td>
<td></td>
<td></td>
<td>0.200</td>
</tr>
<tr>
<td>Σ</td>
<td></td>
<td></td>
<td></td>
<td>1.800</td>
</tr>
</tbody>
</table>

Dak roof = 0.42 kN/m²

<table>
<thead>
<tr>
<th>No</th>
<th>Jenis Beban Mati</th>
<th>Berat satuan</th>
<th>Tebal (m)</th>
<th>Q (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Waterproffing</td>
<td>22.0</td>
<td>0.01</td>
<td>0.220</td>
</tr>
<tr>
<td>2</td>
<td>Berat plafon dan rangka</td>
<td></td>
<td></td>
<td>0.200</td>
</tr>
<tr>
<td>Σ</td>
<td></td>
<td></td>
<td></td>
<td>0.420</td>
</tr>
</tbody>
</table>

Live Load
Slab Basement = 1.92 kN
(Lahan parkir SNI – 1727 – 2013)
Slab 1st = 4.79 kN
(Koridor lantai pertama SNI – 1727 – 2013)
Slab 2nd - 4th = 3.83 kN
(Koridor diatas lantai pertama SNI – 1727 – 2013)
Dak roof = 1.00 kN
(Beban hidup dak atap SNI – 1727 – 2013)

Wall Loads
The load a half brick wall is 2.5 kN/m².
(q₀ = 2.5 kN/m², including dead load according PPPURG 1987)
- To be as a uniform load to beam :
  \[ W = q₀ * h = 2.5 * h \] (height each story).
- Height each story \( h₁ = 3.00 \) m and \( h₂ = 4.00 \) m
  \[ W₁ = 2.5 * 3 = 7.5 \text{ kN/m} \]
  \[ W₂ = 2.5 * 4 = 10 \text{ kN/m} \]

Wind Loads (Wx and Wy)
In the define wind loads, the data must be known, is wind velocity on the area of

![Figure 4.23 Section properties](image)

4. Define Loads

Dead Load
Self weight the structure :
Concrete material, weight unit per volume = 24 kN/m³ with concrete quality fc 21 Mpa. Steel material deform (BJTD40) Steel material shear (BJTP24).
building, with search data from BMKG the wind velocity in the Cirebon on Mundu is, 
( v = 9 km/h ) because in SAP2000 input the wind velocity must be use unit mph, so 
( v = 5.592 mph).

**Earthquake (EQx and EQy)**

There are many parameter if define input the earthquake loads, the new earthquake 
analysis is based on SNI – 1726 – 2012, and website www.puskim.go.id it is the 
website if define site class earthquake.

This is, the steps input the loads in SAP2000:

**Figure 4.40**

Load patterns

**Figure 4.41** Kinds of loads
5. **Run Analysis**

Before doing the Run Analysis, there are some parameters that must be edited and input, as follows:

- Select the load combination, input and then move to the right, in order to design by SAP2000.
- Edit reduction factor based on design code ACI-99:

![Figure 4.55 reduction factor for concrete](image1)

- Choose the options from type of analysis structure:

![Figure 4.56 Type of analysis structure](image2)

- Run Analysis:

![Figure 4.57 Run Analysis](image3)

- **6. Output SAP2000 (Analysis structure PT. TEMPO LAND):**
  - **Output Earthquake Analysis:**
    Self weight each floor on the structure,

  ![Table 4.6 The lateral force each floor](image4)

  - **Lateral Force on each floor (Fx):**
    Each structure should be analyzed for the influence of static lateral force is applied independently in both directions orthogonal. In every direction were reviewed, lateral static force must be applied simultaneously in each floor. For analysis purposes, the lateral force in each floor is calculated by a formula, as follows:
    \[
    F_x = 0.01 \times W_x
    \]
    With:
    \[F_x\] = lateral force each floor
    \[W_x\] = Self weight structure is work each floor.

  ![Figure 4.55 reduction factor for concrete](image5)
Output Rebar Area:

Output rebar area, given by SAP2000 are rebar require (design rebar), and then for calculate rebar used, using manual method.

**Figure 4.63** Rebar area of Sloof and beam secondary

**Figure 4.67** Rebar area of Sloof and beam primary
Figure 4.69 Rebar area of Sloof and beam primary

Figure 4.72 Rebar area of Column K1,K2,K3
C. RESULT ANALYSIS AND CHECK THE STRUCTURE

The result of Analysis

The result analyze are compare from manual with excel method and SAP2000. The following are result for analysis structure sloof (tie beam), beam, and column :

Table 4.7 The result of analysis

<table>
<thead>
<tr>
<th>Frame/Slab Type</th>
<th>Longitudinal Shear</th>
<th>Longitudinal Shear</th>
<th>Longitudinal Shear</th>
<th>Longitudinal Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sloof Anak (Sa)</td>
<td>400</td>
<td>401</td>
<td>402</td>
<td>403</td>
</tr>
<tr>
<td>Sloof Induk (S1)</td>
<td>404</td>
<td>405</td>
<td>406</td>
<td>407</td>
</tr>
<tr>
<td>Sloof Induk (S2)</td>
<td>408</td>
<td>409</td>
<td>410</td>
<td>411</td>
</tr>
</tbody>
</table>

Table 4.8 The result analysis manual slab

<table>
<thead>
<tr>
<th>FRAME</th>
<th>Tulangan Arah x (mm)</th>
<th>Tulangan Arah y (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelat Lantai Type S</td>
<td>Ø10 - 125</td>
<td>Ø10 - 125</td>
</tr>
<tr>
<td>Pelat Lantai Type A</td>
<td>Ø10 - 150</td>
<td>Ø10 - 150</td>
</tr>
<tr>
<td>Pelat Lantai Type B</td>
<td>Ø10 - 150</td>
<td>Ø10 - 150</td>
</tr>
<tr>
<td>Pelat Lantai Type C</td>
<td>Ø10 - 150</td>
<td>Ø10 - 150</td>
</tr>
</tbody>
</table>

Check The Structure

After getting the results of rebar used from frame section sloof (tie beam), beam and column, then will check the deflection from analysis SAP2000 the beam frame. The formula for check deflection are (L/480) based on SNI – 2847 – 2013 “Perencanaan Struktur Gedung Beton Bertulang”. The result for check deflection are as follow :
D. THE BUDGET OF STRUCTURE

A. CONCLUSION

Based on the result of analysis and discussion, it can be concluded as follows:

1. In analyzing the structure with SAP2000, the steps that must be done consists of modeling the structure, define material, define and design frame section, define the load patterns and run analysis model of the structure.

2. The results from analysis structure are as follows:
   a. Internal forces (moment, axial and shear) that will be used in the design phase of the structure. In the design of the structure (output SAP2000) is produced rebars required by the elements (frame) structure.
   b. The result from analysis lateral force (earthquake), it can concluded the lateral force greatest is 14,864 kN.
   c. The result from analysis structure using SAP2000 with manual method, is almost same, but there are some differences at number of rebars on sloof and beam, the result as follows:

Table 5.1 The different result analysis structure.
d. From manual analysis slab, there are differences from data project PT. TEMPO LAND, the differences are as follows:

**Table 5.2 The different result analysis manual slab**

<table>
<thead>
<tr>
<th>FRAME</th>
<th>DATA PROJEK</th>
<th>DATA HASIL ANALISIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelat Lantai Type S</td>
<td>Ø10 - 125</td>
<td>Ø10 - 125</td>
</tr>
<tr>
<td>Pelat Lantai Type A</td>
<td>Ø10 - 200</td>
<td>Ø10 - 150</td>
</tr>
<tr>
<td>Pelat Lantai Type B</td>
<td>Ø10 - 150</td>
<td>Ø10 - 150</td>
</tr>
<tr>
<td>Pelat Lantai Type C</td>
<td>Ø10 - 200</td>
<td>Ø10 - 150</td>
</tr>
</tbody>
</table>

e. The result from check ratio color (SAP2000) on the structure, that produce green color for beams and blue color for columns, but there are 2 (two) columns is get yellow colors, and then from check the deflection it can, the value greatest from balok induk B1 is 7,339 mm with span is 5700 mm, but not more than deflection permit (L/480) is 11,875 mm. So it can be concluded that, the structure from PT. TEMPO LAND is safe.

f. The vertical load of pile group is 595,706 kN, less than more from the maximum load permitted is 1128,704 kN, it can be concluded that the foundation in PT. TEMPO LAND is safe.

3. From the result analysis budget of the structures, it can be total budget structures is Rp6,170,934,880,400,-

**B. RECOMMENDATION**

The recommendation submitted regarding this thesis, are as follows:

1. In the analysis using SAP2000, needed preliminary design and accurate when inputted the data included material, section properties and loads.

2. Regarding the design of the structure, according to the design code (standar perencanaan).

**REFERENCES**


http://www.ilmusipil.blogspot.co.id
http://www.purbolaras.wordpress.com
http://www.puskim.go.id/