Planning Earthquake-Resistant Upper Building Structures With Moment Grabbing Frame System In The Mardhika Park Apartment Building 20 Floors Tambun – Bekasi

Holis Muhlisin¹*, Ribut Nawang Sari², Sukatja³

Department of Civil Engineering, Faculty of Engineering and Computer Science, Jakarta Global University, Indonesia, 16412

ABSTRACT

Indonesia is an area with a high level of vulnerability to earthquake disasters, where this earthquake has caused a lot of losses and damage to building structures. Therefore, to reduce the risk due to the earthquake, it is necessary to plan earthquake-resistant building structures. The structural planning of building construction is needed to get the most effective and efficient dimensions and configuration of the structure. Collapsed buildings that are not strong enough to withstand lateral loads caused by the earthquake have resulted in significant loss of property and even lives. The purpose of writing this thesis is to design an earthquake-resistant Mardhika Park Apartment Building with a moment-resisting frame system (SRPM) which is planned in accordance with SNI 1726:2019 Earthquake (Earthquake Resistance Planning Procedures for Building and Non-Building Structures), SNI 2847 for Reinforced Concrete: 2019 (Requirements for structural concrete for buildings and their explanations), and the loading in accordance with SNI 1727:2020 for (Minimum Loads for Design of Buildings and Other Structures). The structural design of the Mardhika Park Apartment Building includes the design of this superstructure which includes columns, beams, and floor plates. Then the loads that are reviewed for structural element planning are dead, live, and earthquake loads. To assist in calculating the structure is also used Software “SAP2000” to facilitate the calculation of the structure.

Keywords:
SRPM
Reinforced concrete structure
Building Planning
Earthquake Resistance

*Corresponding Author:
Holis Muhlisin
Department of Civil Engineering, Faculty of Engineering and Computer Science, Jakarta Global University, Indonesia, 16412
Email: holizmuzlin@gmail.com

1. INTRODUCTION

Population development in Indonesia is considered very fast. The growth rate in Indonesia is quite significant. This means that the need for housing for the increasing population is also increasing. Besides the need for this is increasing, on the other hand, the availability of land for housing or housing is very limited. It is the needs of the population that will demand development in big cities such as Bekasi City to meet the needs for housing for its people [1]. The continuous population growth coupled with immigrants who want to change their fate in big cities has resulted in increasingly limited land in Bekasi City to be used as a place to live.

Bekasi and surrounding areas (Jabodetabek) are earthquake-prone areas. Although this earthquake did not cause any damage, Jakarta residents who live in high-rise buildings and apartments felt a stronger shock [2].
There have been several times Jakarta and its surroundings have been rocked by earthquakes [3]. This shows that the same disaster can be repeated in Bekasi and its surroundings because the facts prove that the history of earthquakes always repeats itself in a certain period of time. Therefore, high-rise buildings in Bekasi and its surroundings must be built with earthquake-resistant construction to prevent structural failure so that it is expected to minimize the damage that occurs and the loss of life due to the earthquake that occurs [4].

The apartment is a model of residence that only takes up a small part of the space of a building. In addition, apartments are also intended for housing or residence as a solution to the limited residential land in big cities such as Bekasi city. As one of the large densely populated cities with limited residential land. This apartment building is expected to meet the residential needs in the densely populated city of Bekasi with limited residential land.

And to reduce the risk due to the earthquake, it is necessary to plan earthquake-resistant building structures [5]. Mardhika Park Apartment Building 20 Floors, Tambun - Bekasi with a reinforced concrete structure using a structural method in the form of a Special Moment Bearing Frame System (SRPMK) which is planned not only to be adapted to SNI 1726:2019 Earthquake to design buildings that are able to withstand earthquake loads [6]. However, planning is also needed in accordance with the latest existing SNI standards. For the planning of the building using SNI Reinforced Concrete 2847:2019 Requirements for structural concrete for buildings and their explanations [7][8]. And the loading is in accordance with SNI 1727:2020 for the minimum load for the design of buildings and other structures [9][10].

2. METHOD

The data used to plan earthquake-resistant superstructure planning with moment resisting frame system in Mardhika Park Apartment Building 20 Floors, Tambun – Bekasi, namely primary data, and secondary data.

1. Primary Data
Primary data is data obtained from direct observation and research both in the development area and around the construction site, which will later be used as a source in structural design. These data include:
1. Project working drawing
2. Project location point
3. Building data

![Figure 1. Project Location](image1)

2. Secondary Data
The process of collecting data needed for planning the structure of the building, namely:
A. Literature studies or reference materials used in the completion of this thesis include:
1. SNI 2847-2019, Structural Concrete Requirements for Buildings and Explanation.
Planning Earthquake-Resistant Upper Building Structures with Moment Grabbing 

(Holis Muhlisin)

3. SNI 1726-2019, Procedures for Planning Earthquake Resistance for Building and Non-Building
4. Journals and books related to the analysis of the calculation of the structure of high-rise buildings.

B. Selection of Design Criteria

From the data obtained, it will be designed using the Special Moment Resistant Frame System (SRPMK) method, with the earthquake area being zone 4.

- Technical Data:
  1. Upper Structure
     a. Plate = K 300
     b. Beam = K 300
     c. Column = K 300
     d. Reinforcement : fy = 240 MPa (Hoop reinforcement)
        fy = 400 MPa (principal reinforcement)
     e. Quality of concrete fc’ = 35 Mpa

- Non-Technical Data

  Non-technical data is data that functions as support and planning, such as the condition and location of the project location.

1. Project Data
   a. Project Name : Mardhika Apartment Structure Planning Park Tambun - Bekasi
   b. Building Function : Residential
   c. Number of Floors : 20 Floors
   d. Elevation height of each floor:
      - 1st floor : 3.80 m
      - 2nd floor : 3.60 m
      - Floors 3 to 13 : 3.10 m
      - Stairs Roof Dak : 2.75 m
      - Lift Roof Dak : 4.10 m
   e. Location : Jl. Kebon Kelapa No.25, Tambun, Kec.Tambun Sel., Bekasi Regency, West Java
   f. Building Structure : Reinforced Concrete Frame Construction
   g. Roof Structure : Concrete Construction (Dak)
   h. Building Material : Concrete Structure
Plans and Sections Apartment

Figure 2. 1st Floor Plan

Figure 4. 3rd to 11th Floor Plan

Figure 5. 12th to 20th Floor Plan
3. RESULTS AND DISCUSSION

3.1. Preliminary Design

a. Beam Dimension Planning

Table 1. Beam Dimension Planning

<table>
<thead>
<tr>
<th>Kode</th>
<th>Lb</th>
<th>h min</th>
<th>h</th>
<th>b</th>
<th>h pakai</th>
<th>b pakai</th>
<th>Dimensi</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI 1</td>
<td>720</td>
<td>45</td>
<td>43,714</td>
<td>29.142</td>
<td>90</td>
<td>45</td>
<td>45/90</td>
</tr>
<tr>
<td>BI 2</td>
<td>450</td>
<td>28,125</td>
<td>27,321</td>
<td>18,214</td>
<td>80</td>
<td>40</td>
<td>40/80</td>
</tr>
<tr>
<td>BI 3</td>
<td>605</td>
<td>37.812</td>
<td>36.732</td>
<td>24.488</td>
<td>75</td>
<td>35</td>
<td>35/75</td>
</tr>
<tr>
<td>BI 4</td>
<td>605</td>
<td>28.809</td>
<td>27.985</td>
<td>18.656</td>
<td>70</td>
<td>35</td>
<td>35/70</td>
</tr>
<tr>
<td>BI 5</td>
<td>605</td>
<td>28.809</td>
<td>27.985</td>
<td>18.656</td>
<td>50</td>
<td>25</td>
<td>25/50</td>
</tr>
</tbody>
</table>

b. Floor Plate Thickness Planning

For plate dimensions from floor 1 to 20, the thickness of the plate for the floor and roof is 150 mm, and for the 21st floor or the roof of stairs and lifts using a 100 mm plate.

c. Column Dimension Planning

In SNI 2847:2019 article 18.7.2.1 that the smallest cross-sectional size should not be less than 300 mm and the ratio between the smallest cross-sectional size to the size in the perpendicular direction should not be less than 0.4.
3.2. Structure Modeling

Input material data based on the planned quality, namely $f' = 40$ Mpa and for the quality of the main reinforcing steel it is planned to be $f_y = 400$ Mpa, and for the quality of the stirrup reinforcing steel it is planned to be $f_y = 240$ Mpa.
Figure 7. Input concrete quality data (a) $\text{fc} = 40 \text{ MPa}$, (b) $\text{fy} = 400 \text{ Mpa}$, (c) $\text{fy} = 240 \text{ Mpa}$

Enter the dimensions of the beam, column and floor slab based on the preliminary design that has been done.

Figure 8. dimensions of the beam (a) 450x900, column (b) 900x900 and floor slab (c) 150m
After defining the dimensions of the columns, beams, floor slabs, then a drawing is carried out based on the grids that have been made.

Figure 9. View X-Y Axis Building Structure Modeling

Figure 10. View 3D Building Structure Modeling
3.3. Burden

Types of loads acting on buildings include:

a. **Self-dead load of structural elements (Dead Load)**
   The self-weight of the structural elements (self-weight) consisting of columns, beams and plates has been calculated automatically in SAP2000 by providing a self-weight multiplier equal to 1.

b. **Additional element dead load (Super Dead Load)**

1. **Additional dead load on Floor Slab**
   Dead loads acting on floor slabs include:
   - Weight of sand 1cm thick = 0.01 x 16 = 0.16 kN/m²
   - Specific weight 3cm thick = 0.03 x 22 = 0.66 kN/m²
   - Weight of 1 cm thick ceramic = 0.01 x 22 = 0.22 kN/m²
   - Ceiling and hanging weight = 0.2 kN/m²
   - ME Installation Weight = 0.25 kN/m²
   Total dead load on floor slab = 1.49 kN/m²

2. **Additional dead load on roof slab**
   Dead loads acting on the roof slab include:
   - Weight of waterproofing with a thickness of 2cm = 0.02 x 14 = 0.28 kN/m²
   - Ceiling and hanging weight = 0.2 kN/m²
   - ME Installation Weight = 0.25 kN/m²
   Total dead load on the roof slab = 0.73 kN/m²

3. **Additional dead load on beam**
   Dead loads acting on beams include:
   - 1st floor wall load (3.8m - 0.8) x 2.5 = 7.50 kN/m²
   - Floor load 2 (3.6m - 0.8) x 2.5 = 7.00 kN/m²
   - Floor load 3-20 (3.1m - 0.8) x 2.5 = 5.75 kN/m²
   - Top wall load (2.75m - 0.5) x 2.5 = 5.625 kN/m²
   - Top wall load (4.1m - 0.5) x 2.5 = 9.00 kN/m²

c. **Live Load (Live Load)**
   The amount of live load on the floor of the building is determined based on the reference to SNI 1727 – 2020.
   - Lt.1 live load (Restaurant Area) = 4.75 kN/m²
   - Living expenses 2nd floor (Education + Clinic) = 3.84 kN/m²
   - (1.92kN/m² + 1.92 kN/m²)
   - Living load Lt.3 - 20 (Bedroom) = 1.92 kN/m²
   - Live load on top floor (flat roof) = 0.96 kN/m²
   - Live load Lt. not roof stairs & elevator = 0.96 kN/m²
d. **Response Spectrum**

In determining KDS, what we need to know is the value of the acceleration of the short response spectrum (Ss) and the speed of acceleration of the response spectrum of 1 second (S1). The values of Ss and S1 can be seen on the response map of the SNI 1726:2019 spectra. However, to get more accurate Ss and S1 values, the author uses an auxiliary program, namely the Indonesia Earthquake Map Spectra Response Program 2019. And the results obtained are:

- **City Name**: Tambun (C)
- **Longitude**: 107.0616 Degrees
- **Latitude**: -6.2641 Degrees
- **Site Class**: Elementary School - Medium Ground
- **PGA**: 0.376025 g
The results of the Bekasi City Earthquake Design Response Spectrum can be seen in the graph below:

Figure 11. Graph of Medium Soil Spectrum Response
3.4. Structural Analysis

Structural analysis was carried out after entering all dead loads, live loads and earthquake loads into the SAP2000 modeling and loading combinations based on SNI 1726:2019. Then the results of the Structural Analysis are obtained as follows:

![Figure 12](image1.png)
![Figure 12](image2.png)

(a) Modeling after Run in SAP2000 (a), Moment structure after Run in SAP2000 (b)

3.4.1. Moments and Forces on Beams

The moments and forces acting on each beam are positive design moments due to factored loads (Mu+), negative design moments due to factored loads (Mu-), and design shear forces due to factored loads (Vu).

1. Beam B1 450 x 900

<table>
<thead>
<tr>
<th>Element Force – Frames Balok B1 450 x 900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Text</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>656</td>
</tr>
</tbody>
</table>

Plan B1 Shear Moment and Force

Moment (Mu+) = 376.31 KN/m
Moment (Mu-) = -581.67 KN/m
2. Shear Force \( (V_u) = 366.61 \text{ KN} \)

| Element Force – Frames Balok B2 400 x 800 |
|---|---|---|
| Frame | Step Type | V2 | M3 |
| Text | Text | kN | kN/m |
| 276 | Max | 319.532 | 325.127 |
| 453 | Min | -232.334 | -345.72 |

Plan B2 Shear Moments and Forces
\[
\text{Moment (Mu +)} = 325.127 \text{ KN/m} \\
\text{Moment (Mu -)} = -345.72 \text{ KN/m} \\
\text{Shear Force (Vu)} = 319.53 \text{ KN}
\]

3. Beam B2 400x 800

| Element Force – Frames Balok B3 350 x 750 |
|---|---|---|
| Frame | Step Type | V2 | M3 |
| Text | Text | kN | kN/m |
| 606 | Max | 260.741 | 367.423 |
| 606 | Min | -284.03 | -401.409 |

B3 Planned Shear Moment and Force
\[
\text{Moment (Mu +)} = 367.423 \text{ KN/m} \\
\text{Moment (Mu -)} = -401.409 \text{ KN/m} \\
\text{Shear Force (Vu)} = 260,741 \text{ KN}
\]

4. Beam B4 300x 700

| Element Force – Frames Balok B4 350 x 700 |
|---|---|---|
| Frame | Step Type | V2 | M3 |
| Text | Text | kN | kN/m |
| 544 | Max | 163.465 | 231.824 |
| 633 | Min | -180.414 | -274.167 |

Momen dan Gaya Geser Rencana B4
\[
\text{Momen (Mu +)} = 231.824 \text{ KN/m} \\
\text{Momen (Mu -)} = -274.167 \text{ KN/m} \\
\text{Gaya Geser (Vu)} = 163.465 \text{ KN}
\]
5. Beam B5 250 x 500

### Element Force – Frames Balok B5 250 x 500

<table>
<thead>
<tr>
<th>Frame</th>
<th>Step Type</th>
<th>V2</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1891</td>
<td>Max</td>
<td>2.004</td>
<td>22.405</td>
</tr>
<tr>
<td>1894</td>
<td>Min</td>
<td>9.356</td>
<td>-46.661</td>
</tr>
</tbody>
</table>

B4 Planned Shear Moment and Force
- Moment (Mu+) = 231,824 KN/m
- Moment (Mu-) = -274.167 KN/m
- Shear Force (Vu) = 163.465 KN

#### 3.4.2. Moments and Forces on Columns

The moments and forces acting on each column are positive design moments due to factored loads (Mu+), and negative design moments due to factored loads (Mu-).

1. Column K1 900 x 900

<table>
<thead>
<tr>
<th>Kondisi</th>
<th>P (kN)</th>
<th>M2 (kN-m)</th>
<th>M3 (kN-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P max</td>
<td>355.522</td>
<td>61.143</td>
<td>125.534</td>
</tr>
<tr>
<td>P min</td>
<td>-11518.083</td>
<td>-708.114</td>
<td>-558.724</td>
</tr>
<tr>
<td>M2 Max</td>
<td>-2059.127</td>
<td>712.805</td>
<td>615.885</td>
</tr>
<tr>
<td>M2 Min</td>
<td>-8904.410</td>
<td>-713.209</td>
<td>-546.056</td>
</tr>
<tr>
<td>M3 Max</td>
<td>-1664.438</td>
<td>650.189</td>
<td>624.499</td>
</tr>
<tr>
<td>M3 Min</td>
<td>-7942.474</td>
<td>-660.098</td>
<td>-627.786</td>
</tr>
</tbody>
</table>

2. Column K2 800 x 800

<table>
<thead>
<tr>
<th>Kondisi</th>
<th>P (kN)</th>
<th>M2 (kN-m)</th>
<th>M3 (kN-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P max</td>
<td>145.997</td>
<td>15.887</td>
<td>26.277</td>
</tr>
<tr>
<td>P min</td>
<td>-6600.574</td>
<td>-389.012</td>
<td>-353.353</td>
</tr>
<tr>
<td>M2 Max</td>
<td>-275.339</td>
<td>468.132</td>
<td>353.111</td>
</tr>
<tr>
<td>M2 Min</td>
<td>-6593.107</td>
<td>-457.213</td>
<td>-344.101</td>
</tr>
<tr>
<td>M3 Max</td>
<td>105.139</td>
<td>441.757</td>
<td>357.153</td>
</tr>
<tr>
<td>M3 Min</td>
<td>-6425.323</td>
<td>-368.349</td>
<td>-356.666</td>
</tr>
</tbody>
</table>

**Gaya Teken Terkecil**

<table>
<thead>
<tr>
<th>Nu (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
</tr>
</tbody>
</table>
3. Column K3 700 x 700

<table>
<thead>
<tr>
<th>Kondisi</th>
<th>P (kN)</th>
<th>M2 (kN-m)</th>
<th>M3 (kN-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P max</td>
<td>4.323</td>
<td>44.376</td>
<td>54.721</td>
</tr>
<tr>
<td>P min</td>
<td>-5299.452</td>
<td>-355.674</td>
<td>-268.227</td>
</tr>
<tr>
<td>M2 Max</td>
<td>-1093.042</td>
<td>372.718</td>
<td>141.572</td>
</tr>
<tr>
<td>M2 Min</td>
<td>-5248.219</td>
<td>-360.192</td>
<td>-278.244</td>
</tr>
<tr>
<td>M3 Max</td>
<td>-1694.672</td>
<td>216.975</td>
<td>409.002</td>
</tr>
<tr>
<td>M3 Min</td>
<td>-4208.798</td>
<td>-214.204</td>
<td>-409.766</td>
</tr>
</tbody>
</table>

Gaya Tekan Terkecil

<table>
<thead>
<tr>
<th>Nu (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
</tr>
</tbody>
</table>

4. Column K4 650 x 650

<table>
<thead>
<tr>
<th>Kondisi</th>
<th>P (kN)</th>
<th>M2 (kN-m)</th>
<th>M3 (kN-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P max</td>
<td>3.489</td>
<td>13.483</td>
<td>5.199</td>
</tr>
<tr>
<td>P min</td>
<td>-98.833</td>
<td>7.150</td>
<td>13.112</td>
</tr>
<tr>
<td>M2 Max</td>
<td>-25.939</td>
<td>36.825</td>
<td>98.550</td>
</tr>
<tr>
<td>M2 Min</td>
<td>-61.109</td>
<td>-49.986</td>
<td>-37.126</td>
</tr>
<tr>
<td>M3 Max</td>
<td>-25.939</td>
<td>36.825</td>
<td>98.550</td>
</tr>
<tr>
<td>M3 Min</td>
<td>-65.175</td>
<td>10.750</td>
<td>-97.743</td>
</tr>
</tbody>
</table>

Gaya Tekan Terkecil

<table>
<thead>
<tr>
<th>Nu (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
</tr>
</tbody>
</table>

3.4.3. Calculation of Floor Plate Reinforcement

1. Strength Need

- Longest span
  - Iy = 6050 mm
- Shortest span
  - Ix = 3600 mm
- Full clamped plate condition,
  - Iy/Ix = 1.7
- From the plate table (PBI 1971) obtained:
  - Clx = 37
  - Cly = 16
  - Ctx = 79
  - Cty = 5

2. Momen perlu:

- Field Direction x: Mu lx = 0.001.Clx.qu. Lx² = 4031804.16 N.mm
- Field Direction y: Mu ly = 0.001.Cly.qu. Lx² = 1743482.88 N.mm
- Direction x: Mu tx = 0.001.Ctx.qu. Lx² = 8608446.72 N.mm
- Direction y: Mu ty = 0.001.Cty.qu. Lx² = 6211157.76 N.mm

3. Design Power

- Concrete Quality: Fc' = 40 MPa
- Steel Quality: fy = 400 MPa
- Blanket Thickness: sn = 20 mm
- Plate Thickness: b = 150 mm
- Plate Width: = 1000 mm
4. Shortest Span [Lx]

Ultimate Moment

\( M_{Lx} = 4031804.16 \text{ N.mm} \)

Diameter of reinforcement used

\( D = 10 \text{ mm} \)

The distance between the x-direction of the main reinforcement to the tensile fiber

\( d_s = 25 \text{ mm} \)

Effective height of plate

\( d = 125 \text{ mm} \)

Strength reduction factor

\( \Phi = 0.9 \)

5. Longest Spread [Ly]

Ultimate Moment

\( M_{Ly} = 1743483 \text{ N.mm} \)

Diameter of reinforcement used

\( D = 10 \text{ mm} \)

The distance between the x-direction of the main reinforcement to the tensile fiber

\( d_s = 35 \text{ mm} \)

Effective height of plate

\( d = 115 \text{ mm} \)

Strength reduction factor

\( \Phi = 0.9 \)

<table>
<thead>
<tr>
<th>Field</th>
<th>Pedestal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Spans</td>
<td>Long Span</td>
</tr>
<tr>
<td>[Lx]</td>
<td>[Ly]</td>
</tr>
<tr>
<td>D10 - 250</td>
<td>D10 - 250</td>
</tr>
<tr>
<td>D10 - 250</td>
<td>D10 - 250</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Based on the results of the planning of the Mardhika Park Apartment Building Structure 20 Floors, Tambun – Bekasi, by using the Special Moment Bearing Frame System (SRPMK) based on SNI 1726:2019, SNI 1727:2018, and SNI 2847:2019 using the SAP2000 program and structural components designed on beams and columns, the following conclusions can be drawn:

1. The structure is planned as a Special Moment Bearing Frame System (SRPMK), with the following values:
   - R (response modification coefficient) : 8
   - \( 0 \) (strong factor over system) : 3
   - \( Cd \) (strong factor over system) : 5.5

2. On a beam with dimensions of 45/90 obtained:
   - Field Reinforcement : Tensile – 20D25, Push – 18D25
   - Shear Reinforcement :
     - Left Joint
       - Plastic Joint Area : 13 – 50 mm
     - Plastic Joint Outer Area : 13 – 85 mm
     - Right Joint
       - Plastic Joint Area : 13 – 50 mm
       - Plastic Joint Outer Area : 13 – 85 mm

3. On a beam with dimensions of 40/80 obtained:
   - Field Reinforcement : Tensile – 16D25, Push – 16D25
   - Right Support Reinforcement : Pull – 18D25, Push – 16D25
   - Shear Reinforcement :
     - Left Joint
     - Plastic Joint Area : 13 – 50 mm

4. On a beam with dimensions of 35/75 obtained:
   - Field Reinforcement: Tensile – 14D25, Push – 14D25
   - Shear Reinforcement:
     - Left Joint
     - Plastic Joint Area: 13 – 50 mm
     - Plastic Joint Outer Area: 13 – 85 mm
     - Right Joint
     - Plastic Joint Area: 13 – 50 mm
     - Plastic Joint Outer Area: 13 – 85 mm

5. On a beam with dimensions of 35/70 obtained:
   - Shear Reinforcement:
     - Left Joint
     - Plastic Joint Area: 13 – 50 mm
     - Plastic Joint Outer Area: 13 – 85 mm
     - Right Joint
     - Plastic Joint Area: 13 – 50 mm
     - Plastic Joint Outer Area: 13 – 85 mm

6. On a beam with dimensions of 25/50 obtained:
   - Field Reinforcement: Tensile – 12D25, Push – 12D25
   - Shear Reinforcement:
     - Left Joint
     - Plastic Joint Area: 13 – 50 mm
     - Plastic Joint Outer Area: 13 – 85 mm
     - Right Joint
     - Plastic Joint Area: 13 – 50 mm
     - Plastic Joint Outer Area: 13 – 85 mm

7. In a column with dimensions of 900/900 and the amount of reinforcement 16D25, the shear reinforcement is obtained:
   - Plastic Joint Area: 13 – 100 mm
   - Joint Area: 13 – 90 mm
   - Plastic Joint Outer Area: 13 – 150 mm

8. In a column with dimensions of 800/800 and the amount of reinforcement 13D25, the shear reinforcement is obtained:
   - Plastic Joint Area: 13 – 100 mm
   - Joint Area: 13 – 90 mm
   - Plastic Joint Outer Area: 13 – 150 mm

9. In a column with dimensions of 700/700 and the amount of reinforcement 13D25, the shear reinforcement is obtained:
   - Plastic Joint Area: 13 – 100 mm
Joint Area: 13 – 90 mm
Plastic Joint Outer Area: 13 – 150 mm

10. In a column with dimensions of 650/650 and the amount of reinforcement 13D25, the shear reinforcement is obtained:
- Plastic Joint Area: 13 – 100 mm
- Joint Area: 13 – 90 mm
- Plastic Joint Outer Area: 13 – 150 mm

11. In the capacity design planning, the column has met the concept of “Strong Column Weak Beam”. At joints as follows:
1,373,307,000.00 Nmm > 10,251,066.67 Nmm.

12. In the beam-column connection, horizontal restraints are installed 12 and for vertical restraints use column longitudinal reinforcement.

ACKNOWLEDGEMENTS
I would like to thank my parents, Advisors 1 and 2, all staff and employees of Griya Prima Cipta Company, staff and employees of the Civil Engineering Department, Global University Jakarta, and Special Nika Afrianti Sonia Fatimah, S.M., who always give prayers, encouragement and support. motivation for the author to be able to complete this final project.

REFERENCES (10 PT)
[8] Procedure for Calculation of Concrete Structures for Buildings, SNI 2847-2019