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Structural Calculation of the East Kalimantan Regional Police Flats T. 1800 in Penajam Paser Utara

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Abstract**—** *The construction of the 3-Story East Kalimantan Regional Police Flat, Prototype T. 1800, is an effort to improve facilities and infrastructure within the East Kalimantan Regional Police. Therefore, the structural components of the building must be precisely calculated. The superstructure functions to support the forces acting on a building, while the substructure resists and transfers these forces to the ground. Columns, beams, and slabs are crucial structural components in building construction. Structural calculations begin with calculating the loads in accordance with SNI 1727:2020 and 1726:2019, which are then input into SAP 2000. The results of the SAP 2000 analysis include internal forces such as moments (M), shear forces (D), and normal forces (N), which are used to design the required reinforcement area for structural components. From the calculation obtained for a 12 cm thick plate with reinforcement Ø10-150 mm (X-direction field reinforcement and X-direction support) and Ø10-150 mm (Y-direction support reinforcement and Y-direction field). In the B1 beam 25/50 cm obtained 3D16 for support, 3D16 for field, Ø10-150 mm for support shear reinforcement and Ø10-200 mm field shear reinforcement. In the K1 column 40/40 cm obtained 8D16 main reinforcement and Ø10-150 mm for shear reinforcement.*

Keywords**—** *Building Structure Calculation, Building Reinforced, East Kalimantan Regional Police Flats.*

I. INTRODUCTION

The construction of the 3-Story Flats for the East Kalimantan Regional Police, Prototype T. 1800, is an effort to improve facilities and infrastructure within the East Kalimantan Regional Police. The superstructure functions to support the forces acting on a building, while the substructure functions to withstand and channel these forces to the ground. Columns, beams, and slabs are crucial structural components in building construction. For this reason, the structural components must be calculated and analyzed based on the appropriate combination of loads and internal forces based on the SNI 2847: 2019 reference.

One program that can be used for structural planning and calculations is SAP2000 software. Using this program, it is hoped that the structural planning and calculation process can be carried out quickly, accurately, and efficiently, while minimizing errors due to human error.

II. LITERATURE REVIEW

When calculating building structures, it is necessary to pay attention to the rules so that the building meets the applicable regulatory criteria. Government Regulation Number 4 of 1988 concerning Apartments establishes the Basic Provisions for Apartments.

A. Basic Structure

According to the 2020 KBBI (Big Indonesian Dictionary), structure is the way something is arranged or constructed. A building structure is part of a building system that functions to distribute the loads caused by the building's presence on the ground. In principle, structural elements function to support the existence of non-structural elements such as walls, ceilings, and so on. Building structures can also be concluded to function to provide the strength and rigidity necessary to prevent a building from collapsing. Parts of a building that support loads such as foundations, beams, columns, slabs, and so on are referred to as structural parts (Lie & Alo, 2024).

According to SNI 1726:2019, a building structure consists of a superstructure and a substructure. The superstructure is the part of the building structure located above ground level. The substructure is the part of the building structure located below ground level, which can consist of the basement structure and/or the foundation structure.

B. Loading

Structural calculations must be able to channel the loads to the foundation properly without collapse, for the loads acting on a building including dead loads, live loads, wind loads and earthquake loads as explained in SNI 1727:2020 concerning Minimum Loads for Designing Buildings and Other Structures.

C. SAP 2000

SAP 2000 is a computer program that can be used to create new structures, design structural elements, and modify structures. The program's strength lies in its comprehensiveness and capability in modularizing structural analysis with structural element modules. It is designed to be highly interactive, allowing for several functions, such as controlling stress conditions in structural elements, changing the dimensions of beams and columns (frames), and changing design rules without changing the initial analysis.

There are two geometric models in SAP 2000, namely template and coordinate models. The template model is used if all distances are the same for the X-axis to the Z-axis. Meanwhile, the coordinate model is used if the distance is not the same in the X-axis to the Z-axis.

III. RESEARCH METHODOLOGY

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The location of the East Kalimantan Regional Police Flats T. 1800 building is on Jalan Negara KM. 37 RT. 21 Sukaraja Village, Sepaku District, North Penajam Paser Regency, East Kalimantan Province.

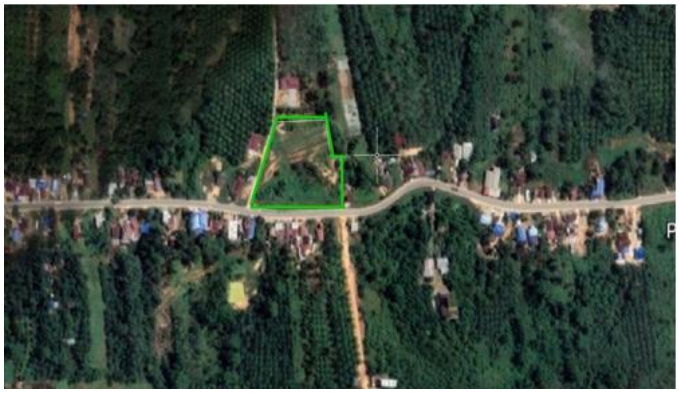

Fig. 1. Project Location

A. Calculation Method

1) Dimensional calculation
Calculation of structural element dimensions refers to SNI 2847:2019 (Structural Concrete Requirements for Buildings and Explanations).

2) Load calculation
The calculation method for the loading used is based on SNI 1727:2020 (Minimum Design Loads and Related Criteria for Buildings and Other Structures).

3) Structural reinforcement calculation
The reinforcement of structural components is calculated according to the rules contained in SNI 2847:2019 (Structural Concrete Requirements for Building Structures and Explanations).

4) Tools used
The tools used in this calculation are SAP 2000 software and Microsoft Excel software.

B. Work Flowchart

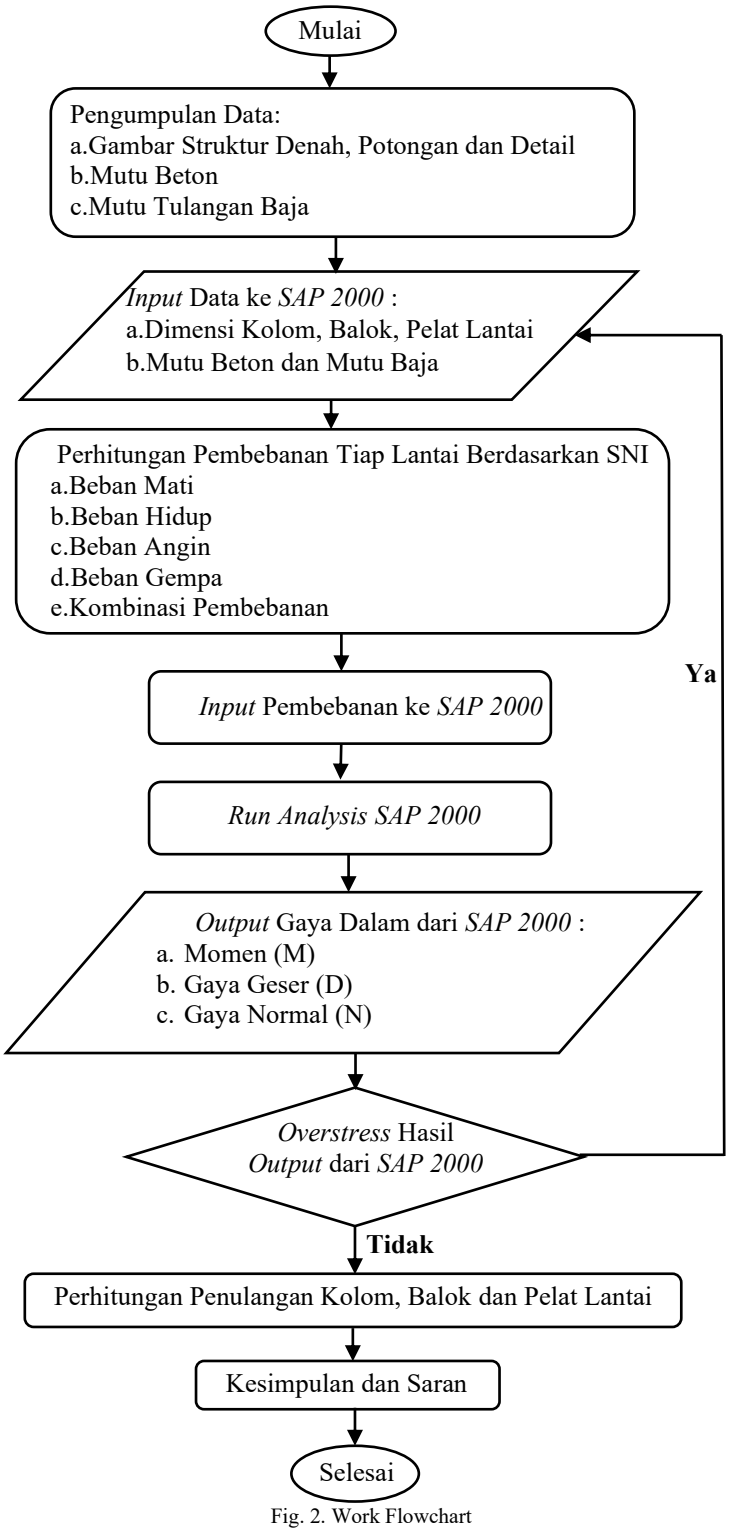

Fig. 2. Work Flowchart

IV. Research Results and Explanation

A. Construction Standards and Specifications

In the calculation of the building of the East Kalimantan Regional Police Flats T. 1800 in North Penajam Paser, the following references were used:

1) SNI 1727:2020: Building Design.
2) SNI 2847:2019: Structural Concrete Requirements for Buildings.
3) SNI 1726:2019: Earthquake Resistance Planning Procedures for Building and Non-Building Structures.

The construction standards and specifications contained in the East Kalimantan Regional Police Flats building T. 1800 are as follows:

1) Concrete Quality : f'c 24,90 Mpa
2) Reinforcing Steel Quality : fy 420 Mpa for main reinforcement
: fy 280 Mpa for shear reinforcement
3) Sloof : S1 = 250 x 500 mm
: S2 = 200 x 400 mm
: S3 = 200 x 350 mm
4) Column : K1 = 400 x 400 mm
: K2 = 300 x 300 mm
5) Beam : B1 = 250 x 500 mm
: B2 = 200 x 400 mm

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: B3 = 200 x 350 mm
6) Ring Balk : RB1 = 200 x 400 mm
: RB2 = 200 x 350 mm
7) Plate Thickness : Floor 1,2,3 = 120 mm
: Roof floor = 100 mm

B. Loading

The loading data according to the minimum load calculation based on SNI 1727:2020 guidelines is as follows :

1) Self weight of concrete = 2200 Kg/m^2
2) Self weight of reinforced concrete = 2400 Kg/m^2
3) Weight of cement mixture = 21 Kg/m^2
4) Weight of ½ red brick wall = 250 Kg/m^2
5) Weight of ceramic tile = 24 Kg/m^2
6) Weight of ceiling = 11 Kg/m^2
7) Weight of ceiling suspension frame = 10 Kg/m^2
8) Mechanical and electrical weight = 25 Kg/m^2
9) Live load weight of apartment floor = 250 Kg/m^2
10) Live load weight of human load = 100 Kg/m^2

C. Dead Load

The SNI dead load is the dead load on the plate, and not the self weight of the plate or column, the self weight has been automatically calculated in the SAP.

- Dead load on floors 2 and 3

1) Weight of ceiling suspension frame = 10 Kg/m^2
2) Weight of ceiling = 11 Kg/m^2
3) Mechanical and electrical weight = 25 Kg/m^2
4) Thickness of the specimen (2,5 cm) = 52,5 Kg/m^2
5) Weight of ceramic tile = 24 Kg/m^2 +
D_L = 122,5 Kg/m^2

- Dead load on the roof slab

1) Weight of ceiling suspension frame = 10 Kg/m^2
2) Weight of ceiling = 11 Kg/m^2
3) Mechanical and electrical weight = 25 Kg/m^2 +
D_L = 46 Kg/m^2

D. Dead load of walls on the main structure

The wall load is used as a dead load by calculating the uniform load on the beams of floors 1, 2 and 3. The height of each floor is 4 m. The walls in the main structure use ½ red brick wall pairs with a weight of 250 Kg/m^2 in accordance with SNI 1727:2020.

- Evenly distributed load on walls on floors 1, 2 and 3

Formula = weight of wall masonry ½ red brick x wall height
= 250 kg/m^2 x 4 m = 1000 kg/m^2

E. Live Load

1) Live load weight of apartment floors = 250 Kg/m^2
2) The weight of human life = 100 Kg/m^2

F. Wind Load

1) The wall on the windward side = 0,8
2) The wall on the windward side goes = -0,5
3) Edge wall = -0,7

G. Earthquake

1) Site class = SE (Soft Soil)
2) Responspectrum parameter at short period (Ss) = 0,0696
3) Responspectrum parameter at 1 sec (S_1) = 0,0799

H. 12 cm thick floor slab reinforcement

1) Plate Thickness = 120 mm
2) Concrete Cover = 25 mm
3) Short span length = 2,5 m
4) Long span length = 3,5 m

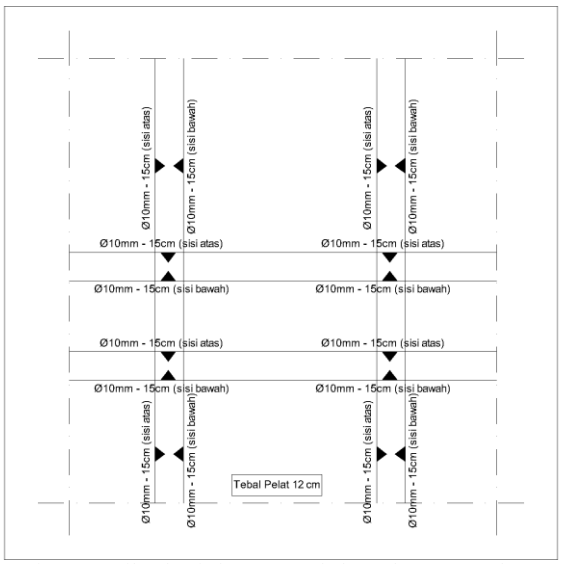

Fig. 3. Details of Reinforcement of Floor Plates 1, 2 and 3

I. 10 cm thick floor slab reinforcement

1) Plate Thickness = 100 mm
2) Concrete Cover = 25 mm
3) Short span length = 3,5 m
4) Long span length = 4,5 m

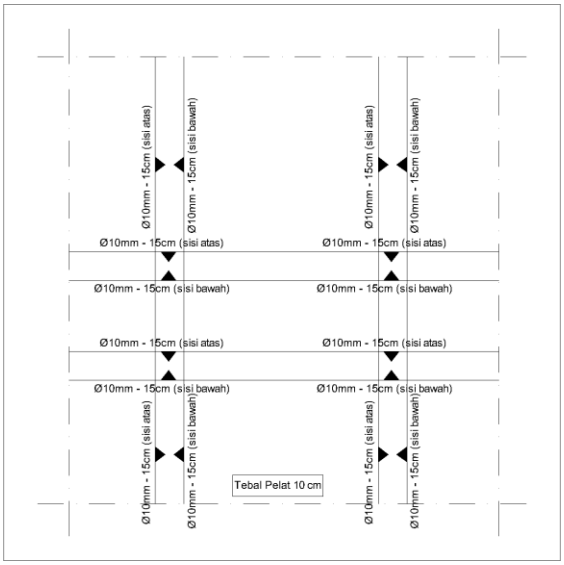

Fig. 4. Floor Plate Reinforcement Details

J. Beam Reinforcement

1) Wide = 250 mm
2) Tall = 500 mm

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3) Beam Span = 7000 mm
4) Principal Reinforcement = Ø16 mm
5) Stirrup Reinforcement = Ø10 mm
6) Concrete Blanket = 25 mm

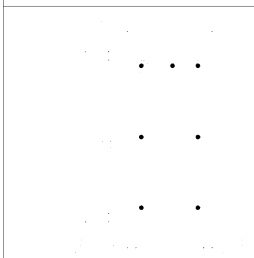
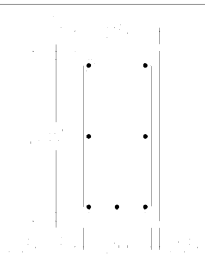
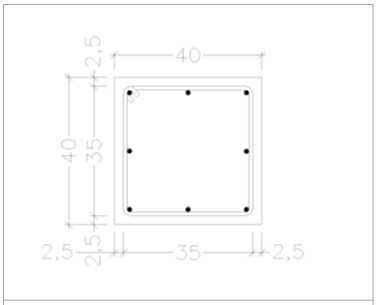
TULANGAN TUMPUAN	TULANGAN LAPANGAN
	
3Ø16	2Ø16
2Ø16	2Ø16
2Ø16	3Ø16
Ø10-150	Ø10-200

Fig. 5. Beam Reinforcement Details

K. Beam Reinforcement

1) Wide = 400 mm
2) Tall = 400 mm
3) *Column Span* = 4000 mm
4) Principal Reinforcement = Ø16 mm
5) Stirrup Reinforcement = Ø10 mm
6) Concrete Blanket = 25 mm



3Ø16
2Ø16
3Ø16
Ø10-150

Fig. 6. Column Reinforcement Details

V. CONCLUSION AND SUGGESTIONS

A. Conclusions

➢ Based on the results of the load calculations on the structure of the East Kalimantan Regional Police Flats Building T. 1800, as follows:

1) Dead Load
   - Dead load on floors 2 and 3 = 122,5 Kg/m^2
   - Dead load on the roof slab = 46 Kg/m^2
   - Evenly distributed load on walls on floors 1, 2 and 3 = 1000 kg/m^2
2) Live Load
   - Live load weight of apartment floors = 250 Kg/m^2
   - The weight of human life = 100 Kg/m^2
3) Wind Load
   - The wall on the windward side = 0,8
   - The wall on the windward side goes = -0,5
   - Edge wall = -0,7
4) Earthquake
   - Site class = SE (Soft Soil)
   - Responspectrum parameter at short period (Ss) = 0,0696
   - Responspectrum parameter at 1 sec (S_1) = 0,0799

➢ The results of the structural analysis of the East Kalimantan Regional Police Flats Building T. 1800 in North Penjam Paser using SAP 2000 Software, obtained the maximum moment and shear forces, as follows:

1) The 25 x 50 beam with the largest support moment is 95,120 kNm, the field moment is 71,491 kNm, and the shear force is 78,122 kN.
2) The 40 x 40 column with the largest bearing moment is 72,646 kNm, the field moment is 67,927 kNm, and the shear force is 36,110 kN.

➢ The results of the structural reinforcement calculations for the East Kalimantan Regional Police Flats Building T. 1800 in North Penjam Paser using SAP 2000 Software are as follows:

1) Floor Slabs
   On a 12 cm thick floor slab, use a two-way slab and use X-direction field reinforcement, namely D10 – 150, Y-direction field reinforcement, namely D10 – 150, then use X-direction support reinforcement, namely D10 – 150, Y-direction support reinforcement using D10 – 150. Then on a 10 cm floor slab, use a two-way slab and use X-direction field reinforcement, namely D10 – 150, Y-direction field reinforcement, namely D10 – 150 then use X-direction support reinforcement, namely D10 – 150, Y-direction support reinforcement using D10 – 150.
2) Beam
   In the 25 x 50 beam, the field reinforcement is 3D16, the support reinforcement is 3D16, for shear reinforcement, the minimum shear reinforcement is used with the cross-sectional stirrup reinforcement for the support is Ø10-150 and for the field is Ø10-200, then for torsion reinforcement, 1D16 is used.
3) Column
   In Column 40 x 40, the main reinforcement is 8D16 and for shear reinforcement, it is Ø10-150.

B. Suggestions

Suggestions that can be submitted in the Calculation of the Structure of the East Kalimantan Regional Police Flats Building T. 1800 in North Penjam Paser using SAP 2000 Software are as follows:

1) Maximum precision is required to obtain maximum and appropriate results in using SAP 2000 software.
2) Can understand the basics and use of SAP 2000 software.

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3) Recheck the data used in creating the model in SAP 2000 software and the SNI used.

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