JOURNAL OF WORLD SCIENCE
https://jws.rivierapublishing.id/index.php/jws
Volume 3 No. 1 January 2024
P-ISSN: 2828-8726
E-ISSN: 2828-9307

SLAB PLANNING OF A 5-STOREY APARTMENT BUILDING ON JALAN PEMUDA SEMARANG

Sumarman
Universitas Swadaya Gunung Jati, Cirebon, Indonesia
smrirmt_196579@yahoo.com

ABSTRACT

This research focuses on the design of a bidirectional reinforced concrete slab for a 5-storey apartment building located on Jalan Pemuda, Semarang, following SNI 1726:2019 standards. The objective is to compare the results of the direct design method (DDM) using Excel with ETABS v18 software, analyzing the accuracy of traditional methods in modern structural designs. The study employed a practical approach, incorporating various design parameters such as beam dimensions, span length, dead and live loads, and material strengths (f'c and fy). The results indicate that although there is a slight difference between the methods, they exhibit similar trends. The study found that increased load leads to higher moments, while larger beams and higher concrete strength reduce reinforcement requirements. However, discrepancies between the methods were observed due to rounding errors in the DDM. The research suggests refining moment calculation techniques and enhancing software tools for more accurate slab designs. The findings are essential for improving design accuracy in both academic and professional practice, particularly for earthquake-resistant structures.

Keyword : Plate Design, Plate Calculation, Bidirectional Plate

Corresponding Author: Sumarman
E-mail: smrirmt_196579@yahoo.com

INTRODUCTION

Pelat is a structural system designed to support both live and dead loads. The adhesive properties of this system include a small thickness, wide shape, and good resistance to bending. Several types of systems exist, such as flat pelat, wafer pelat, ribbed pelat, and conventional pelat systems. The conventional tiChain system is a commonly used floor system, known for its durability and reliability in supporting irregular floor plate configurations. In general, pelat can be categorized into one-sided and two-sided systems. The design process itself utilizes several methods, including the same frame method and direct design approach. Additionally, the plate design must comply with relevant standards and regulations, particularly in the event of natural disasters like earthquakes, which can significantly damage the soil layer and the structure.

The design of reinforced concrete slabs plays a crucial role in modern structural engineering, particularly in multi-storey buildings. In earthquake-prone areas, ensuring the resilience of such structures becomes even more important. This research focuses on the slab design for a five-storey apartment building located on Jalan Pemuda, Semarang. The study compares two distinct methods for slab design: the Direct Design Method (DDM) and the use of ETABS v18 software, with an emphasis on the accuracy of traditional methods versus modern computational tools in structural design.

Reinforced concrete slabs, particularly those in buildings with multiple storeys, must be able to efficiently transfer both live and dead loads. Their design must take into account various factors, such as material strength, beam dimensions, and the effects of seismic activity. Given the complexity of the interactions within the structure, modern structural design often relies on software tools like ETABS, which allows for comprehensive structural analysis, including the effect of dynamic loads. However, the traditional method of Direct Design has been widely used for many years and remains relevant in certain practical applications, particularly when rapid results are needed or when software tools are not accessible.

The objective of this study is to investigate the differences in outcomes between the Direct Design Method (DDM), performed using Excel spreadsheets, and the ETABS v18 software. By comparing the results from both methods, this research aims to assess the reliability of traditional techniques in modern structural design, especially in terms of accuracy and efficiency. The findings are particularly valuable for engineers involved in the design of earthquake-resistant structures, as they provide insights into potential discrepancies and areas for improvement in existing design practices.

Moreover, the research evaluates the role of various design parameters, including beam sizes, span lengths, reinforcement diameters, and material strengths, in shaping the performance of the slab system. By considering the impact of these variables on the overall design, the study seeks to refine the design process and improve the accuracy of results obtained from both design methods. The findings also aim to contribute to the understanding of how different design methods can influence the reinforcement requirements and bending moment calculations in reinforced concrete slabs.

In addition, this research investigates the effects of varying load conditions on the slab design, exploring how increased loads affect the bending moments and, consequently, the reinforcement needs. The study also highlights the importance of using accurate software tools, such as ETABS, which provide a more comprehensive and precise analysis of structural behavior compared to traditional methods. The comparison of the two design methods is expected to offer practical insights for engineers and designers in the field of structural engineering, enabling them to make informed decisions about the best approach for slab design in different situations.

In conclusion, this study serves as a valuable reference for both academic and professional practice in structural engineering. It aims to bridge the gap between traditional and modern design approaches by providing a comparative analysis of the Direct Design Method and ETABS software. The results will contribute to improving the design of reinforced concrete slabs, particularly in the context of earthquake-resistant buildings, and will aid in the development of more reliable and efficient design practices for multi-storey buildings in earthquake-prone areas.

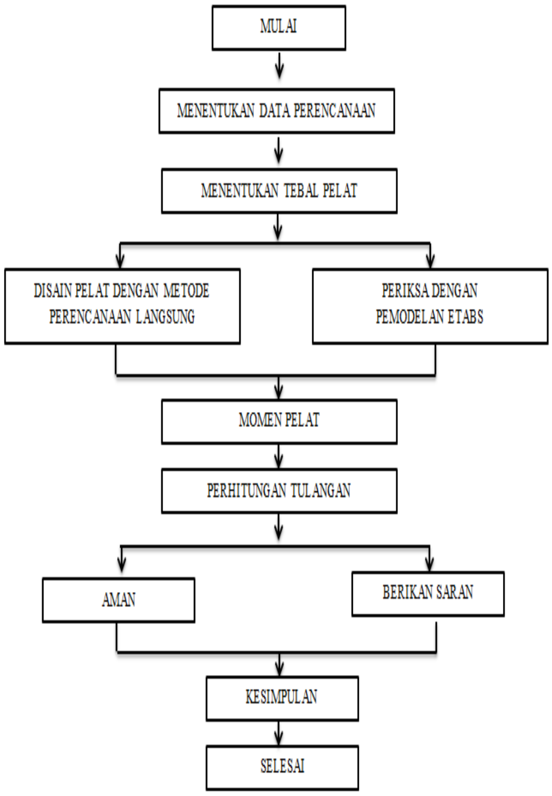
The slab design adheres to a series of criteria, including reinforced concrete guidelines that have evolved over time. The minimum standards for the planning and construction of locally produced or pre-manufactured concrete structures were first established in the 1971 PBI, which includes tables and nomograms for reference. Since no tabulations have been made according to the latest rules, which could simplify the planning process, this task will focus on the two-way design of a conventional slab system. This design will follow the new regulations outlined in SNl 1726:2019. The outcome of this work will be a table featuring useful plate designs with different variations based on the sizes commonly used in the field. The design process follows the guidelines provided by SNl 1726:2019, and will calculate the moment or distance of reinforcement required for the plate design. It is expected that this work will serve as a valuable reference for field planning.

The limitations of this research include the use of the Bidirectional Design Method (DDM) for the direct design approach, with guidelines based on SNl 1726:2019. The conventional slab system considered in this study includes peIat with beams at all concentrations. Calculations were performed using the Excel 2010 application program, while structural analysis results were obtained using the ETABS v18 software. For control calculations, the Excel application was utilized. The variations in the results include column size, beam dimensions, span length, dead load, live load, reinforcement diameter, f'c, and fy.

The novelty of the current research lies in the application of a Bidirectional Design Method (DDM) for the calculation of bending moments in concrete slabs, specifically for a 5-storey apartment building in Semarang. This research addresses discrepancies between the results from the direct design method (using Excel) and structural analysis software (ETABS v18). The study proposes improvements to the direct design approach by considering load variations, beam sizes, and material strengths, which have not been extensively covered in previous studies. Additionally, the research explores the impact of reinforcement sizes and compressive strengths (f'c) on the overall slab performance, offering a practical reference for future building designs in earthquake-prone areas.

METHOD

The location of the research is located on Jalan Pemuda Semarang



RESULTS AND DISCUSSION

Structural material data

- Compressive strength of concrete,
  Fc' + 30 Mpa
- Steel melting stress for bending reinforcement
  Fy = 280 Mpa

Floor Plate Data

Length of the span of the direction plate x, Lx = 3.00 m length of the span of the floor plate, h = 125 mm
Plate moment coefficient for:
TWO DIRECTIONS, Because Ly/Lx < 2Field x,
Clx = 31 Field y
Cly = 19 Fields x
Ctx = 69 Focus y
Cty = 57 Focus x

Floor Plate Load

1. Beban Mati (Dead load)
   QD = 4.32 Kn/ m^2
2. Living Burden
   QL = 1.92 kn/ m^2
3. Factored planning load
   Qu = 8,256 kn/ m^2
4. Plate moment due to factored load

Momen Lapangan Arah x (Mulx)	2,303 kNm/m
Momen Lapangan Arah y (Muly)	2,510 kNm/m
Momen Tumpuan Arah x (Mutx)	5,127 kNm/m
Momen Tumpuan Arah y (Muty)	7,529 kNm/m

Plate repetition

Data-data :

- Width of the plate reviewed 1 m wide
- Plate thickness h = 125 mm→
- Selimut beton dc = 20 mm →
- Diameter of the reinforcement used 10 mmØ
  Ly/Lx = 1 (plate coefficient)

Effective thickness of floor plate,dx=h-dc-() $^{\text{Ø}}/_{2}$

= 125 – 20 - () $^{10}/_{2}$

= 100 mm

Effective thickness of floor plate,dy = h - dc - () $^{\text{Ø}}/_{2}$

= 125 – 20 – ()$^{10}/_{2}$

= 90 mm

For : Fc' ≤ 28 Mpa, 1 = 0.85 β

Form factor of concrete stress distribution, 1 = 0.85 β

TEBAL (mm)	Frame		Mu	ØMn	As Perlu	As Pakai	Tulangan
			kNm	kNm	mm2	mm2	
125	ARAH X	Lapangan bawah	23,0	28.7	500	628	D10 - 100
		Tumpuan atas	-51.2	64,0	500	628	D10 - 100
	ARAH Y	Lapangan atas	25.1	31.3	450	628	D10 - 100
		Tumpuan bawah	-75.2	94.1	450	628	D10 - 100

Plate deflection control

- Modulus of elasticity of concrete, Ec = 25742 Mpa
- Modulus elastisitas baja tulangan, Es =200000 Mpa
- Average load (unfactored) on the plateQ = QD + QL

  = 4.32 + 1.92

  = 6.24 N/mm
- Span length, Lx = 3000 mm
- Maximum allowable deflection limit, Lx / 240 = 12,500 mm
- Moment of inertia crutto plate cross-section, lg = 162,760.416 mm^3
- Modulus keruntuhan lentur beton, fr = 3,384 Mpa
- Nilai modulus ratio elastis, n = 7,769 mm
- Neutral line distance to the top side of the concrete, c = 4.879 mm
- The moment of inertia of the cross-sectional crack that is transformed into concrete is calculated as follows:

  Icr = 1/3 * b * + n * As (d – c $c^3)^2$

  = 1/3 x 1000 x + 7,769 x 628,000 $4{,}879^3$

  $(125 – 4{,}879\ )^2$

  = 44183959.66 mm
- Yt = 62.5 mm
- Momen retak, Mcr = 9984525,788 Nmm
- Maximum moment due to load (without load factor), Ma = 7020000.2 mm
- Effective inertia for deflection calculation, Ie =385352881 mm
- Elastic deflection due to dead load and live load, = 0.66 mmδe
- Floor slab reinforcement ratio, p = 0.006
- Time dependence factor for dead load, value: (> 5 year term), value:

  = 2

  = 1,522
- Long-term deflection due to skeletal and shrinkage, g = 1.01 mm δ
- Lendutan total

$\Delta$to = e + g $\delta\delta$

= 0.66 + 125

= 1.67 < 12.5

CONCLUSION

The results of the moment calculation using the Iangsung design method do not fully align with those from the ETABS v18 software, though the difference is minimal. The direct design method involves rounding moment coefficients, which impacts the final result, while ETABS v18 analyzes the entire structure, yielding more precise results. The study found that as load increases, the resulting moment also increases, and that larger beam sizes reduce moments under the same load. Additionally, higher f'c values reduce the reinforcement area needed. However, some combinations cannot be calculated due to limitations in the quadratic equation. Future research could focus on refining moment calculation methods, addressing discrepancies between design approaches, and improving the accuracy of the direct design method by eliminating rounding errors. Further studies could explore the effects of varying load conditions, beam size, and plate thickness, as well as optimizing reinforcement design based on material strength. Investigating alternative calculation methods or software enhancements to resolve limitations in the quadratic equation would also be beneficial.

REFERENCES

Diky ZuIkarnain, J. T., 2019. Perencanaan Lantai PeIat SIab Berdasarkan Tata Cara SNl 2847 - 2019. Tugas Akhir Departemen Teknik SipiI FT USU.

Depohusodo, lstimawan, 2003. Setruktur Beton BertuIang. Jakarta: PT. Gramedia Pustaka Utama

Eka Susanti, N. A., 2019. Studi Prbandingan PeIat Berussuk Dua Arah (WafIe SIab) dan PeIat KonvensionaI. JurnaI lptek, 35.

McCormac, J. C 2003. Desain Beton BertuIang. Jakarta: ErIangga.

Mohammad Fahrl, S. E., 2017. Tinjauan Momen Lentur PeIat Dua Arah dengan Metode Perencanaan Langsung dan Metode EIemen Hingga. JRSDD, 88.

Badan Standarissasi NasionaI, SNl 2847-2019. Persyaratan Beton StructuraI untuk Bangunan Gedung.

Siiwi, B. R., 2019. ReDesain Struktur Beton BertuIang Pada Asrama KaItim Ruhu Rahayu.