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ANALYSIS OF DIMENSIONAL AND CALCULATIONS STRUCTURE DESIGNED BASED ON SNI 2847-2013

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ABSTRACT

Floor slabs are structural components of a building that have certain dimensions to transmit dead and live loads on them to be distributed to their supports. Designing the floor slabs of a building, load data will be borne by the structure, so that the planned structure is able to bear the loads and forces that work. With careful planning, it is expected that the dimensions and reinforcement of the floor slabs are economical and safe which can avoid deflection and cracks. The building being reviewed is hospitals in Surabaya. This building consists of 9 floors with a height of up to 37 m. Planning dimensions and reinforcement in this hospital building includes two-way slabs with different size variations. The analysis was carried out using the 'envelope method' in accordance with SNI 2847: 2013 (Basics of Reinforced Concrete Planning). The results of the analysis of dimensions and reinforcement in this hospital building are: a) the dimensions / thickness of the plate on the roof plate is 125 mm, while b) the reinforcement used on this floor plate is Ø10-125 and the reinforcement for Ø10-200. Each moment analyzed is contained in the analysis results table and floor slab reinforcement drawings.

Keywords: *Plate; SNI 2847:2013; Dimentions.*

1. Introduction

In planning a building construction, there are two parts of the building, namely the structural and non-structural parts. But in typical cast-in-place construction, beams, columns, and slabs, acts as a single structural unit [1]. Flate slabs are very important part of the structural elements, which also bear the loads that work on the building. Flat slab system is a concrete plate propped on columns without the existence of beams [2]. Flat slabs have several advantages such as a reduced and simpler formwork, versatility, and easier space partitioning, thus making them an economical and efficient structural system [3]. Flat slab and flat plate are declared capable of resisting bending moments and shear forces that occur. The field moment that occurs on the flat plate is greater than the flat slab due to the absence of additional drop panels or column heads on the flat plate [4]. But, It sometimes becomes a challenge for Engineers to arrogate a certain mesh size for floor elements [5]. Plates are one of the structural elements made to accept dead and live loads. Reinforeced concrate plate is thin structure made of reinforced concrate with a plane whose direction is perpendicular to the plane of the structure [6]. The main problem faced in floor slab planning is deflection. Many study was occurred to investigate the immediate and long-term deflections of reinforced concrete slabs subjected to construction load at their early ages [7].

This problem can be caused partly due to errors in dimension and reinforcement planning so that the reinforcement is not sufficient to withstand the working load. In addition, another cause is the use of materials / materials that are not good at the time of installation of reinforcement, which can reduce the strength of reinforced concrete. Basically, good planning is whether the floor slab is strong enough to withstand the load or not. The analytical solution could predict the ultimate load of the strengthened slabs with reasonable accuracy [8]. Because in this planning the dimensions and reinforcement should be used. If the calculation is wrong or experiences an error, it can cause dimensional differences and reinforcement from the calculation results with dimensions and reinforcement that should be installed in the field. For this reason, the writer is interested in taking the title: Dimensional Analysis and Reinforcement of Floor Slabs according to SNI 2847: 2013 [9] in Hospital buildings in Surabaya.

There are several standards used in slab design, namely reinforced concrete rules which have undergone several developments and changes. In PBI 1971, it contains the minimum requirements for planning and implementing reinforced concrete construction that is cast locally or previously made, in which there are tables / nomograms to be used as a reference in planning. Seeing that there are no tables made based on the new rules, which can facilitate planning, in this final project, the researcher will make a practical design of two-way conventional plates. The practical design is based on the new regulation, namely SNI 2847: 2013. Which will produce a practical plate design table, with various variations according to the sizes commonly used in the field. The plate design is made using one of the methods contained in SNI 2847; 2013. This plate design will produce the moment, and distance of the reinforcement to be used. So that it is expected to be used and used as a reference in planning in the field.

2. Material and Methods

RSIA Lombok Dua-Dua is a research on plates that I took in October 2020. The location of the plate judgment in this article is one of the hospital projects in Surabaya which has 9 floors. The floor plate or slab is part of the building structure, which is a plane that has a very small thickness compared to its length and width. The floor slab is a thin plane that carries transverse loads through the bending action to the respective supports of the slab. The plate is very rigid and has a horizontal direction, so that in this part of the building, the plate functions as a horizontal stiffener which is useful for supporting the rigidity of the portal beam [10].

In planning a multi-story building structure, a structure that is capable of supporting its own weight, wind load, live load and special loads acting on the structure is used. The loads that work on the structure are calculated according to SNI 2847: 2013.

2.1. Floor Slab Formula

The steps for calculating the floor slabs are based on SNI 2847: 2013.

a. For $\alpha fm < 0,2$ used table 2.2 (a)

b. For $0,2 < \alpha fm < 2,0$, h cannot be smaller than,

$$h = \frac{ln[0,8+ \frac{fy}{1400})}{36+5\beta(afm-0,2)}$$

and not less than 125 mm

c. For $\alpha fm > 0,2$, the minimum plate thickness should not be less than:

$$h = \frac{\ln\left(0,8+ \frac{fy}{1400}\right)}{36+9\beta}$$

and it should not be less than 90mm

d. On discontinuous edges the edge beam shall have a stiffness ratio f not less than 0.8 oralternatively the minimum thickness specified by Eq. (9-12) or (9-13) must be raised by at least 10 percent on panels with non-continuous edges.

2.2. Moment & Reinforcement

The steps to determine the moment and amount of reinforcement are as follows:

a. Determine the working moment (Mu), calculated with the schema on the 'envelope method', including the field and pedestal moments (Mlx, Mly, Mtx, Mty, Mtx and Mty). [2]

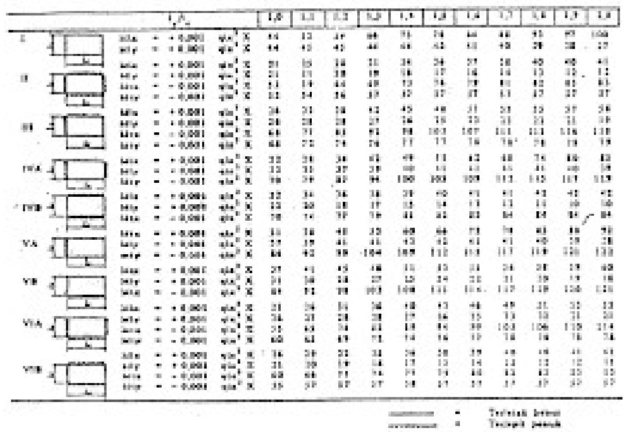


Figure 2.1 Plate Moment Distribution Table

b. Calculate the reinforcement ratio

$$\rho_{min} = \frac{1{,}4}{fy}$$

$$\rho_{maks} = \frac{0{,}85.\beta 1.fc'}{fy} \text{ x } \frac{600}{600}$$

ρ may not to be > 0,5 ρb (SNI 2847-2013 Attachment B.8.4.2) [8]

Reinforcement ratio is necessary ($\rho_{analysis}$):

ρ < ρmin < 0,5 ρb

c. Reinforcement calculations

ASneed = ρmin .b.d

$Asused = \frac{1000}{n} \, x \, \frac{1}{4} \, . \, \pi \, . \, Ø \text{ reinforcement}^2$

ASused > Asneed ……OK [6]

3. Result and Discussion

Structure Data:

Building height	= 9 floor 37m	Concrete quality Fc'	= 30 MPa
Building function	= Hospital	Steel grade Fy	= 240 MPa
Building structure	= Reinforced concrete		

The geometrical data of the shop houses analyzed are as follows:

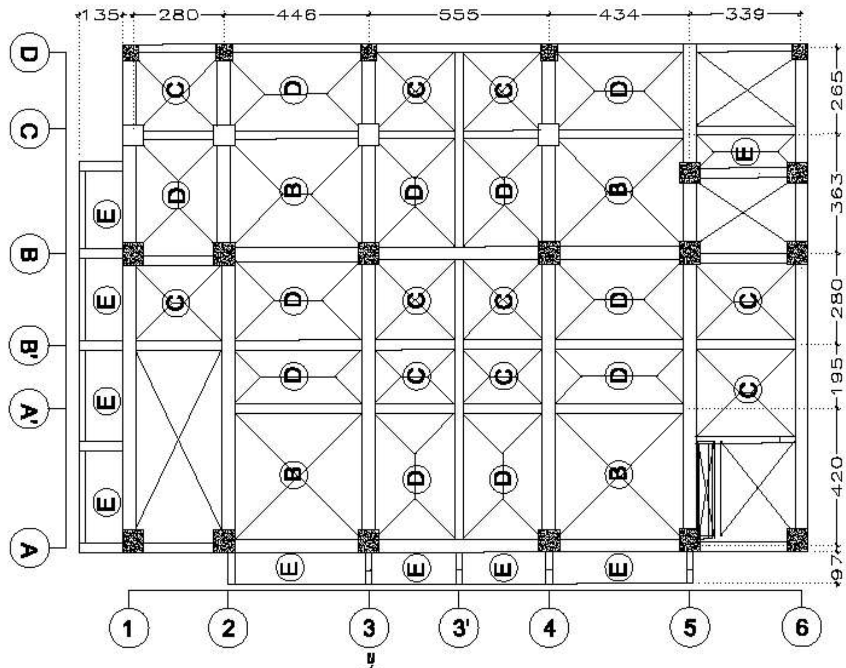
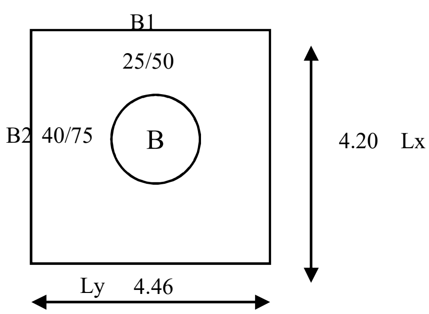


Figure 1. Floor plan 5-9

Two-way plate calculation:



In $= Ly-2(\frac{1}{2}b)$

$= 446-2(\frac{1}{2}.25)$

$= 421cm$

Sn $= Lx-2(\frac{1}{2}b)$

$= 420-2(\frac{1}{2}.40)$

$= 380cm$

β $= \frac{ln}{Sn}$

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$= \frac{421}{380} = 1{,}108$

The minimum plate thickness must not be less than:

$$h = \frac{\ln(0{,}8+\frac{fy}{1400})}{36+9\beta}$$

$$h = \frac{421[0{,}8+\frac{240}{1400})}{36+9.1{,}087}$$

$$h = \frac{408{,}971}{45{,}971}$$

$= 8{,}896cm$

And should not be less than 90 mm (SNI 2847-2013, article 9.5.3.3) Therefore, the planned floor slab thickness (hf) = 12.5 cm [8]
Plate thickness control $\alpha fm > 0{,}2$ [5]

$$h = \frac{ln[0{,}8+\frac{fy}{1400})}{36+5\beta(afm-0{,}2)}$$

$$125 = \frac{4210[0{,}8+\frac{240}{1400})}{36+5.1{,}108\ (afm-0{,}2)}$$

$$125 = \frac{4089{,}714}{36+5{,}54(afm-0{,}2)}$$

$$125 = \frac{4089{,}714}{36+5{,}54afm-1{,}108}$$

$$125 = \frac{4089{,}714}{34{,}892+5{,}54afm}$$

$125.(\ 34{,}892 + 5{,}54afm\ ) = 4089{,}714$

$4361{,}5+692{,}5afm = 4089{,}714$

$692{,}5afm = 4089{,}714-4361{,}5$

$692{,}5afm = -271{,}786$
$afm = -0{,}392$
$\alpha fm < 0{,}2$
Due to $\alpha fm < 0{,}2$ then must use drop panels (SNI 2847-2013 article 9.5.3.2) plan plate thickness (hf) = 12.5cm meets the requirements. [8]

Table 1. Recapitulation of Plate Reinforcement Calculations

Plate B

Ly	4,46	qf	980
Lx	4,2	dx	100
Ly/Lx	1,1	dy	90
Fy	240	B	0,8
Fc	30	B	1000

Plate C

Ly	3,18	qf	980
Lx	2,88	dx	100
Ly/Lx	1,1	dy	90
Fy	240	B	0,8
Fc	30	B	1000

Plate D

Ly	4,53	qf	980
Lx	2,88	dx	100
Ly/Lx	1,6	dy	90
Fy	240	B	0,8
Fc	30	B	1000

Table 2. Recapitulation of Floor Slabs Calculations

No.	Name of plate	x	Mu (KNm)	Rn (Mpa)	m	Pmin	Pmaks	As Perlu (mm^2)	As Ada (mm^2)	Basic Reinforcement		As ada (mm^2)	As bagi (mm^2)	Reinforcement For	
										Øreinforcement	distance			Øreinforcement	distance
1	Plat B	Mlx	4,322	0,576	9,412	0,0058	0,030	580	628	10	125	392,5	175	10	200
		Mly	3,630	0,598	9,412	0,0058	0,030	522	628	10	125	392,5	175	10	200
		Mtx	10,199	1,360	9,412	0,0058	0,030	580	628	10	125	392,5	175	10	200
		Mty	9,335	1,537	9,412	0,0058	0,030	522	628	10	125	392,5	175	10	200
No.	Name of plate	x	Mu (KNm)	Rn (Mpa)	m	Pmin	Pmaks	As Perlu (mm^2)	As Ada (mm^2)	Basic Reinforcement		As ada (mm^2)	As bagi (mm^2)	Reinforcement For	
										Øreinforcement	distance			Øtulangan	distance
2	Plat C	Mlx	5,705	0,761	9,412	0,0058	0,030	580,000	628	10	125	392,5	175	10	200
		Mly	4,840	0,797	9,412	0,0058	0,030	522	628	10	125	392,5	175	10	200
		Mtx	13,311	1,775	9,412	0,0058	0,030	580	628	10	125	392,5	175	10	200
		Mty	12,447	2,049	9,412	0,0058	0,030	522	628	10	125	392,5	175	10	200
No.	Name of plate	x	Mu (KNm)	Rn (Mpa)	m	Pmin	Pmaks	As Perlu (mm^2)	As Ada (mm^2)	Basic Reinforcement		As ada (mm^2)	As bagi (mm^2)	Reinforcement For	
										Øreinforcement	distance			Øtulangan	distance
3	Plat D	Mlx	6,396	0,853	9,412	0,0058	0,030	580	628	10	125	392,5	175	10	200
		Mly	2,766	0,455	9,412	0,0058	0,030	522	628	10	125	392,5	175	10	200
		Mtx	13,657	1,821	9,412	0,0058	0,030	580	628	10	125	392,5	175	10	200
		Mty	9,854	1,622	9,412	0,0058	0,030	522	628	10	125	392,5	175	10	200

As perlu = As need; As ada = As used
(Source: calculation results)

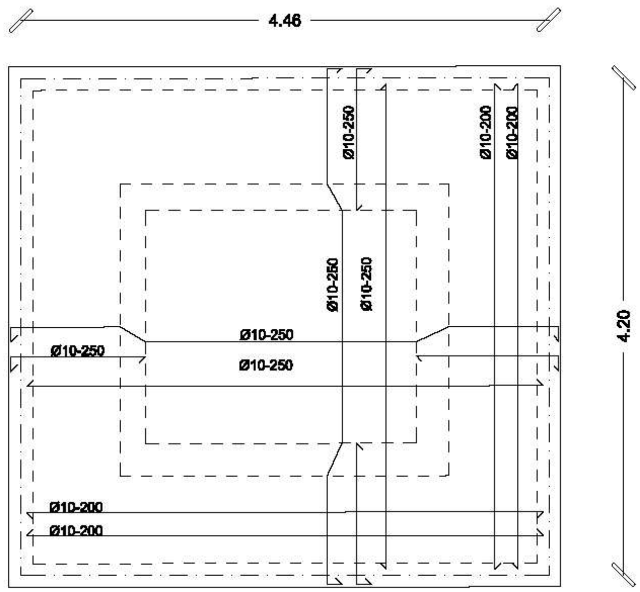

Figure 2. Reinforcement of Type B Floor Slabs
(Source: Analysis, 2019)

From the article obtained with a floor slab thickness off 125mm Ø10-125 main reinforcement and Ø10-125 reinforcement for.

4. Conclusions

From the calculation of the dimensions and plate reinforcement obtained the following data:

a. The thickness of the floor plate used is 125mm.
b. The main reinforcement used is Ø10-125 and the reinforcement for Ø10-200.
c. In the depiction of reinforcement, the calculation results table is used as a guideline for depiction. In the figure, the reinforcement on the support and field is explained in accordance with the calculation results Acknowledgements.

References

[1] Q. Kai, B. Li, Q. He and W. Yi, "Slab effects on response of reinforced concrete substructures after loss of corner column," *ACI STRUCTURAL JOURNAL,* vol. 109, no. 6, pp. 91-101, 2012.

[2] A. S. Saadoon, A. M. Abbas and H. K. Hussain, "A Review on Flat Slab Punching Shear Reinforcement," *Journal of University of Babylon for Engineering Sciences,* vol. 27, no. 3, pp. 44-58, 2019.

[3] F. Stochino and F. L. Gayarre, "Reinforced Concrete Slab Optimization with Simulated Annealing," *applied sciences,* vol. 9, no. 3161, pp. 1-14, 2019.

[4] F. N. Constantine, M. D. J. Sumajouw and R. E. Pandaleke, "STUDI PERBANDINGAN ANALISIS FLAT SLAB DAN FLAT PLATE," *JURNAL SIPIL STATIK,* vol. 7, no. 11, pp. 1397-1406, 2019.

[5] M. M. SAZZAD, M. S. AZAD, M. T. ISLAM and F. I. RAHMAN, "Effect of Mesh Size of Floor Slab against Lateral Loads while using Etabs Program," *International Journal of Advanced Structures and Geotechnical Engineering,* vol. 6, no. 1, pp. 40-44, 2017.

[6] A. Asroni, Reinforced Concrete Beams and Plates, Yogyakarta: Graha Ilmu, 2010.

[7] H.-G. Park, H.-J. Hwang, G.-H. Hong, Y.-N. Kim and J.-Y. Kim, "Immediate and Long-Term Deflections of Reinforced Concrete Slabs Affected by Early-Age Loading and Low Temperature," *ACI STRUCTURAL JOURNAL,* vol. 109, no. 3, pp. 413-422, 2012.

[8] B. Q. Abdulrahman and O. Q. Aziz, "Strengthening RC flat slab-column connections with FRP composites: A review and comparative study," *Journal of King Saud University - Engineering Sciences,* vol. https://doi.org/10.1016/j.jksues.2020.07.005, 2020.

[9] Anonymous, SNI 2847: 2013, Structurall Concrete Requirements for Buildings, Jakarta: National Standardization Agency, 2013.

[10] Anonymous, SNI 1727: 2013, Minimum Load for Designing Buildings and Other Structures., Jakarta: Nasional Standardization Agency, 2013.