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An Analysis Of Floor Plate Reinforcement Structure Calculation Plan On Irian Supermarket Building Road Of Setia Budi Medan

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ABSTRACT
The increasing number of tall buildings being built in the modern era now. Making it increasingly important to calculate accurate and comprehensive structures in accordance with applicable regulations, especially the Indonesian National Standard (SNI) and of course the building to be built is safe from all potential structural failures and the most efficient reinforcement used. In the Irian Supermarket Building project, Setia Budi Medan, an analysis of the level of safety of the floor slab structure is required in accordance with SNI 2847-2019 and an analysis of the most efficient reinforcement that can be used in the floor slab structure of the Irian Supermarket Building, Setia Budi Medan. And the formulation of the problem discussed is the level of safety of the building structure and the most efficient reinforcement that can be used. The research method is carried out using the case study method where the collection of field data and additional data, data is processed in accordance with SNI 2847-2019 and for reinforcement efficiency is done by increasing the distance between the reinforcements. The result is the value of As needed: 652.4 mm2 < As used: 670.4 mm2 for flexural reinforcement (2Ø8-150) and As needed: 455.4 mm2 < As used: 502.4 mm2 for shear reinforcement (2Ø8-200) so that the reinforcement used is safe to use while the total deflection: 16.6 mm > allowable deflection: 6.68 mm and ϕVc: 58650 N/mm > Vu: 32823.07 N/mm so that the thickness of the plate used is 120 mm safe to use. However, reinforcement efficiency cannot be done because the value of As needed: 652.4 mm2 > As used: 455.4 mm2 for flexural reinforcement (2Ø8-200) and As needed: 455.4 mm2 > As used: 401.92 mm2 for shear reinforcement (2Ø8-250) so that reinforcement efficiency cannot be carried out.

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INTRODUCTION

The increasing number of tall buildings built in the modern era now. Makes it increasingly important to calculate accurate and comprehensive structures in accordance with applicable regulations, especially the Indonesian National Standard (SNI). And of course the building to be built is safe from all potential structural failures and the most efficient reinforcement used.

In the building structure, there is one important part, namely the floor plate. The floor plate is a thin structure made of reinforced concrete with a horizontal plane, and the load acting perpendicular to the structure. The thickness of this plate plane is relatively very small when compared to the length/width of its plane. This concrete plate is very rigid and horizontal, so that in building structures, this plate functions as a diaphragm/horizontal stiffener which is very useful for supporting the rigidity of the portal beam.

The planning of reinforced concrete floor slabs in Indonesia refers to many regulations, especially SNI 2847:2019, which is the Indonesian national standard for structural concrete for building structures. This SNI regulates the planning and implementation of reinforced concrete for building structures, including floor slabs, beams, columns, and walls. SNI 2847:2019 is the regulation in force when this research was conducted. In addition to these regulations, there are also other regulations such as SNI 1727-2020 concerning building loading and regulations that have been around for a long time and are often used, namely the Indonesian Concrete Regulation (PBI-71).

Literature Review

Floor Slab

Floor slab is a floor that is not located directly on the ground, it is a floor level boundary between one level and another. The floor slab is supported by beams that rest on the building columns. The thickness of the floor slab is determined by:

a. The desired amount of deflection.
b. The span width or distance between the supporting beams.
c. Construction materials and floor slabs.

Supports on concrete slabs usually consist of various types, such as hinged supports, roller supports, and clamped supports. Each type of support has different characteristics in resisting forces and moments, as well as different applications depending on the needs of the structural design.

Loading on a structure is one of the most important things in planning a building. Mistakes in load planning or applying loads to calculations will result in fatal errors in the design results of the building. For that, it is very important for us to plan the loading calculations properly and carefully so that the building that is designed will be safe when it is built and will be used according to its function.

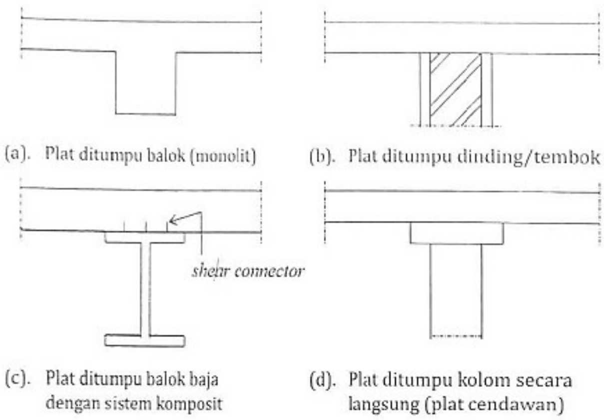

Figure 1. Plate support

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$$U = 1.2.D + 1.6.L \quad (1)$$

Where:
U = Factored load combination
D = dead load
L = live load
Dead Load (D)

Dead load is the weight of all installed building construction materials, including walls, floors, roofs, ceilings, stairs, permanent partition walls, finishing, building cladding and other architectural and structural components as well as other installed service equipment including the weight of cranes and systems, live load is a load caused by users and occupants of a building or other structure that does not include construction loads and environmental loads, such as wind loads, rain loads, earthquake loads, flood loads, or dead loads.

Load Factor

Each structural component is designed to be able to carry a load greater than the service load in order to provide a guarantee of safety against structural failure. The loads acting on the structure can be a combination of various load cases that may occur simultaneously.) which must be considered as the most critical condition that must be borne by a structural element is shown in the table below.

Table.1. Load Combinations

Load Combination	Equality	Main Load
U = 1.4D	(1)	D
U = 1.2D + 1.6L + 0.5(Lror R)	(2)	L
U = 1.2D + 1.6(Lror R) + (1.0L or 0.5W)	(3)	Lr or R
U = 1.2D + 1.0W + 1.0L + 0.5(Lr or R)	(4)	W
U = 1.2D + 1.0E + 1.0L	(5)	E
U = 0.9D + 1.0W	(6)	W
U = 0.9D + 1.0E	(7)	E

Source: SNI 2847: 2019

Information:
U = factored load combination
D = dead load
L = live load
Lr=live roof load
R=rain load
W=wind load
E = earthquake load (earth quake load)

Material

The materials in reinforced concrete floor slabs are concrete and reinforcement in this case related to their quality and reduction factors.

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Table 2. Limits of f'c values

Utility	Types of Concrete	Minimum F'c value (Mpa)	Maximum F'c value (Mpa)
General	Normal weight and light weight	17	There is no limit
Special moment resisting frame system and special structural walls	Normal Weight	21	There is no limit
	Light weight	21	35[1]

The elastic modulus of concrete is regulated in SNI 2847-2019 Article 19.2.2 with the following formula:
For toilet values between 1400 and 2560 kg/m3

$$Ec=wc1.5x0.043xfc'$$

For normal concrete

$$Ec=wc1.5x0.043xfc'$$

Where wc is the volume weight of normal concrete or the equivalent volume weight of lightweight concrete.
Modulus of rupture

The fracture modulus of concrete is regulated \ with the following formula:

$$fr=0.6x\lambda xfc' \quad (2)$$

Where λ is in accordance with table 3 the crack modulus will later become a variable to calculate the cracking moment which is the moment that occurs when the first crack occurs in the concrete structure.

Table 3. Modification factors λ

Concrete	Aggregate Composition	λ
Lightweight concrete with all lightweight aggregates	Fine: ASTM C330M Coarse: ASTM C330M	0.75
Lightweight concrete, with mixed fine aggregate	Fine: Combination of ASTM C330M and C33M Coarse: ASTM C330M	0.75 to 0.851^11
Lightweight concrete with lightweight sand	Fine: ASTM C33M Coarse: ASTM C330M	0.85
Lightweight concrete, with mixed coarse aggregate	Fine: ASTM C33M Coarse: Combination of ASTM C330M and C33M	0.85 to 12^22
Normal concrete	Fine: ASTM C33M Coarse: ASTM C33M	1

Minimum Plate Thickness

Concrete slabs that have a ratio of length between long span and short span of more than or equal to 2 are categorized as one-way slabs. In a one-way slab system, almost all loads are transferred in the short direction. One-way slab design can generally be done like a beam structure that is considered to have a width of 1 m. SNI regulations provide several limitations regarding one-way plate design:
The design was carried out using the assumption of a width of 1 meter.

The minimum thickness of one-way plates using fy = 420 MPa according to SNI 2847:2019 must be determined as shown in Table 4.

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Table 4. Minimum thickness of non-prestressed one-way solid slab

Support Condition	h Minimum
Simple focus	*l/20*
One continuous end	*l/24*
Both ends are continuous	*l/28*
Cantilever	*l/10*

The concrete cover for slab structures should not be less than 20 mm, for slabs that are not in direct contact with the weather and soil.

Table 5. Thickness of concrete cover for cast-in-place non-prestressed concrete structural components.

Exposure	Structural Components	Reinforcement	Cover Thickness, mm
Cast and permanently in contact with the ground	All	All	75
Exposure to weather or contact with soil	All	Bars D19 to D57	50
		D16 Rod, Ø13 or D13 Wire and smaller	40
Not exposed to weather or contact with soil	Plates, ribbed plates and walls	D43 and D57 bars	40
		D36 and smaller bars	20
	Beams, columns, pedestals and tension members	Main reinforcement, stirrups, tie stirrups, spirals, and restraining stirrups	40

The one-way plate structure is perpendicular to the flexural reinforcement. This requirement is regulated in Table 6 the ratio of the area of shrinkage and temperature deformed reinforcement to the gross concrete cross-sectional area must meet the limits as shown in Table 6.

Table.6. Shrinkage and temperature reinforcement requirements for slabs.

Reinforcement	*fy MPa*	Reinforcement ratio minimum	
Threaded rod	< 420	0.0020	
Threaded rod or welding wire	≥420	The largest of	$\frac{0.0018 \times 420}{fy}$
			0.0014

Except for rib plates, the distance between the main reinforcement in the plate must be less than 3 times the plate thickness or no more than 450 mm and the required distance between reinforcement must not exceed 5 times and no more than 450 mm. For one-way slabs and beams, it is permitted to assume:

a. MomentThe maximum positive Mu near the middle of the span occurs with the factored live load L acting fully on the span and on the alternating spans.

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b. MomentThe maximum negative Mu at the support occurs with the factored live load L acting fully only on the adjacent span. The moments calculated according to table 2.11 of SNI 2847-2019 must not be redistributed.

Table 7. Approach moments for the analysis of continuous beams and nonprestressed one-way slabs.

	Location	Condition	Your
Positive	End span	Discontinuous and monolithic ends with placement	$wu./14\ell n^2$
		The ends are not continuous and not pressed	$wu./11\ell n^2$
	Middle span	All	$wu./16\ell n^2$
Negative	Interior face of exterior support	The beams are monolithically integrated with the supporting spandrel beams.	$wu.\ell n^2/24$
		Monolithic beam with supporting columns	$wu./16\ell n^2$
	Exterior face of the first interior support	Two spans	$wu./9\ell n^2$
		More than two spans	$wu./10\ell n^2$
	Face of another supporter	All	$wu./11\ell n^2$
	The faces of all the supporters were filled	(a) Plates with a span of not more than 3 m (b) Beams with a ratio of the sum of the column stiffness to the beam stiffness exceeding 8 at each end of the span.	$wu./12\ell n^2$

It states that for plates built together with supports, Mu and Vu at the supports are permitted to be calculated at the face of the supports.

Plate Reinforcement

Steps in calculating plate reinforcement:

Calculating the effective thickness value (d):

To determine the effective height of the plate, it is viewed from two directions, namely:

a. Direction x (dx) = h – d` – ½.D
b. Direction y (dy) = h – d` – ½.D

Calculating the reinforcement ratio value ρ:

Before calculating the reinforcement area, first calculate the value of ρ that will be used.

$$\rho_b = 0{,}85.\beta.\frac{f'_c}{fy}\left(\frac{600}{600+fy}\right) \quad (3)$$

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

$$\rho_{maks} = \left(\frac{0{,}003+f_y/E_s}{600+fy}\right)\rho_b \quad (5)$$

$$\rho_{Perlu} = \frac{0{,}85.f'_c}{fy}\left[1-\sqrt{1-\frac{2.Mu}{0{,}85.\emptyset.f'_c.b.d^2}}\right] \quad (6)$$

With the requirement: ρmin < ρperlu < ρmaks

Determining the required reinforcement area (As):

As = ρ.bh (7)

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Calculating the Number of Reinforcements

n =A_s/(1⁄4 πD^2) (8)

Calculating reinforcement spacing

s = b/(n-1) (9)

s ≤ 2.h (10)

s ≤ 450 mm

Based on SNI table 8 states that for the cross-section between the support face and the critical section located at a distance d from the support surface for non-prestressed plates, it must be designed to meet Vu at the critical section if it meets: The bearing reaction, in the direction of the shear that occurs, causes pressure to the end region of the plate. The load is applied at or near the top surface of the plate. There is no concentrated load between the support face and the critical section

Table 8. Shear approaches for the analysis of continuous beams or non-prestressed one-way slabs.

Location	Vu
Exterior face of the first interior face support	$1.15wu.ln/2$
Face of another supporter	$wu.ln/2$

States that for each factored load combination used, the design strength at all cross-sections must meet ϕSn > U including:

ϕ Mn >M u

ϕVn > V u

In One-way shear strength design is regulated in table 8 One-way shear strength design The nominal one-way shear strength in the cross-section (Vn) is calculated using the equation:

$$Vn=Vc+Vs \quad (11)$$

Where:

Vn = Nominal shear strength.

Vc = Nominal shear strength provided by the concrete.

Vs = Nominal shear strength provided by shear reinforcement.

The dimensions for cross-section design must meet the following equation:

One-way shear strength design

$$Vu \le \varphi(Vc+0.066*fc'xbwxd) \quad (12)$$

Where:

bw = width of the cross-section under review

d= effective height of shear section

It states that the value of √(f'c) should not be taken more than 8.3 Mpa. In simple terms, the Vc value can be calculated using the following formula:

One-way shear strength design

$$Vc = 0.17\ x\ \lambda\ x\ fc'\ x\ bw\ x\ d \quad (13)$$

And more detailed as mentioned in Table 9.

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Table 9. Detailed methods for calculating Vc

Vc	
The smallest among a), b), and c):	a) $[0.16 fc' + 17 \rho w Vud/Mu] bwd$
	b) $[0.16 fc' + 17 \rho w] bwd$
	c) $0.29 fc' bwd$

METHODOLOGY

The building structure used as the object of research is the Irian Supermarket Setia Budi Building project located on Setia Budi Street, Tanjung Rejo Village, Medan Sunggal District, Medan City. The project location is bordered by shophouses to the north, bordered by Agam Setia Budi coffee shop to the south, bordered by Tasbih Housing Complex to the west, and bordered by Setia Budi Street, Medan to the east.

The technical data for the floor plate of the Irian Supermarket Building, Setia Budi Medan is as follows:

a. Thickness of floor slab 2 : 12 cm.
b. Floor Plate Area 2 : 77.9 m x 35.7 m.
c. Concrete Quality Floor Slabs :f'c= 25 Mpa.
d. Column Concrete Quality :f'c= 25 Mpa.
e. QualityIron : SNI (THREAD) f'y:420 Mpa.
f. TypeBuilding : CenterSupermarket shopping.
g. Number of Floors : 2 Basement Floors and 5floor.

Table 10. Floor plate sizes

Plate Size	Plate Name
2,325 m x 9.6 m	A7
2,325m x 8m	A8
3.5m x 9.6m	A5
3.5 m x 8 m	A6
4 m x 9.6 m	A1
4 m x 8 m	A2
2.5 m x 9.6 m	A3
2.5 m x 8 m	A4
4 m x 4 m	B1
4 m x 6.7 m	B2
2,325 m x 6.7 m	B3
2,325 m x 2.2 m	C1
1.75 m x 5.8 m	C2

RESULTS AND DISCUSSION

Result Plate

If the result of ly/lx < 2 then it is a two-way plate and if ly/lx > 2 then it is a one-way plate. The following determines the calculation of the type of floor plate:

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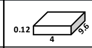
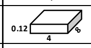
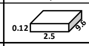
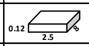
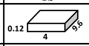
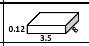
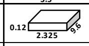
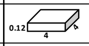
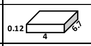
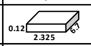
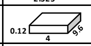
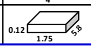
Table 11. Summary of plate type calculations

No	Nama Plat	Tebal Plat(cm)	ly(m)	lx(m)	ly/lx	Jenis Plat	Gambar Plat
1	A1	12	9.6	4	2.4	Satu Arah	
2	A2	12	8	4	2	Satu Arah	
3	A3	12	9.6	2.5	3.84	Satu Arah	
4	A4	12	8	2.5	3.2	Satu Arah	
5	A5	12	9.6	3.5	2.742857	Satu Arah	
6	A6	12	8	3.5	2.285714	Satu Arah	
7	A7	12	9.6	2.325	4.129032	Satu Arah	
8	B1	12	4	4	1	Dua Arah	
9	B2	12	6.7	4	1.675	Dua Arah	
10	B3	12	6.7	2.325	2.88172	Satu Arah	
11	C1	12	2.325	2	1.1625	Dua Arah	
12	A12	12	5.8	1.75	3.314286	Satu Arah	

Based on SNI 2847 – 2019 table 2.8, the minimum thickness value is set as follows: For fy more than 420 MPa, the equation in table 2.8 must be multiplied by (0.4 + fy / 700) Unless the calculation results at the deflection limit are met, the overall thickness of the plate h is allowed to be less than that required in Table 11 so that:

L = lx/28 = 4000/28 = 142.85 mm > reinforcement used = 120 mm. Because the minimum thickness of the plate used in the study did not match table 8 SNI 2847 – 2019, then deflection calculations must be carried out.

Concrete blanket

Based on SNI 2847 – 2019 Article 20.6.1.3.1, non-prestressed concrete structural components cast in place must have a concrete cover of at least as shown in the following table:

Based on the table, the concrete cover taken is h=20 mm.

Floor slab loading consists of dead load (qD) and live load (qL), in this discussion the loading is reviewed without considering earthquake loads and wind loads. Dead load is the load itself from important building materials and from several building components that must be reviewed in determining the dead load of a building. Dead load data is taken from the 1983 PPIUG Appendix.

Table 12. Data Of Dead Load

Plate Weight Alone	0.12	2,400 Kg/m2	288 Kg/m2
Ceramic Weight (1cm)	0.01	2,200 Kg/m2	22 Kg/m2
Specific Load (2cm)	0.02	2,200 Kg/m2	44 Kg/m2
Ceiling Weight + Hangers			18 Kg/m2
Half red brick half stone pair			250 kg/m2
Mechanical Electrical			25 kg/m2
Total			647 Kg/m2 = 6.47 Kn/m2

Live Load

Based on analysed data, the live load calculated in this planning is as follows:

Wholesale Store 4.79 Kn/m2

Load Combination

The formula used in calculating floor slabs is as follows:

qU =1.2.qD + 1.6.qL

qU =1.2.(6.47 Kn/m2) + 1.6.(4.79 kn/m2)

qU = 15,428 Kn/m2

1. A2 Plate Moment Calculation

$$\frac{Ly}{lx} = \frac{9,6}{4} = 2.4$$

Ln = Effective width of the plate

Ln = plate width – (1/2 beam width)

Ln = 400 cm –(1/2.30cm)-(1/2.30cm)

Ln = 370 cm = 3700 mm

Ultimate Moment

$$M1 = \frac{qU.Ln^2}{10} = \frac{15,428.3700^2}{10} = 21.120.932\ N/mm(Negatif)$$

$$M2 = \frac{qU.Ln^2}{14} = \frac{15,428.3700^2}{14} = 15.086.380\ N/mm(Positif)$$

$$M3 = \frac{qU.Ln^2}{24} = \frac{15,428.3700^2}{24} = 8.800.388\ N/mm(Negatif)$$

2. A7 Plate Moment Calculation

$$\frac{Ly}{lx} = \frac{9,6}{2,325} = 4,12$$

Ln = Effective width of the plate

Ln = plate width – (1/2 beam width)

Ln = 232.5 cm – (1/2.30cm) - (1/2.30cm)

Ln = 202.5 cm = 2025 mm

Ultimate Moment

$$M1 = \frac{qU.Ln^2}{10} = \frac{15,428.2025^2}{10} = 6.326.444N/mm(Negatif)$$

$$M2 = \frac{qU.Ln^2}{14} = \frac{15,428.2025^2}{14} = 4.518.888\ N/mm(Positif)$$

$$M3 = \frac{qU.Ln^2}{24} = \frac{15,428.2025^2}{24} = 2.636.018\ N/mm(Negatif)$$

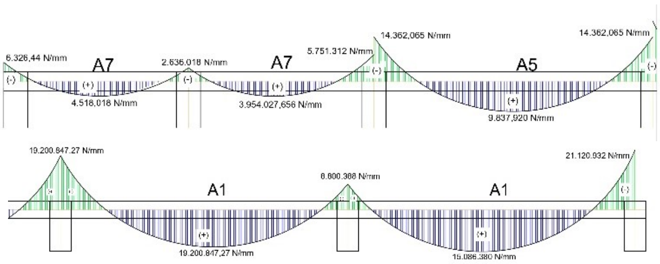


Figure 2. Plate Moment Diagram

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Table 13. Recapitulation of plate moments

No	Plate Name	Mu(+) (N/mm)	Mu(-) (N/mm)	Mu(-) (N/mm)
1	A7	4,518,888	2,636,018	6,326,444
2	A7	3,954,027	2,636,018	5,751,312
3	A5	9,873,920	14,362,065	14,362,065
4	A3	4,666,970	6,788,320	6,788,320
5	A1	13,200,528	19,200,847	8,800,338
6	A1	15,086,380	21,120,932	8,800,338

- Effective height

(d) = h – s – ½ ØD

Where:
h: Plate thickness (120 mm)
s: Concrete cover (20 mm)
ØD: Planned reinforcement: 2 Ø 8mm (2 Layers)
d=120 -20-2(8/2)
d = 92 mm

- Flexural reinforcement area

Mn = Mu/Ø

Mn = 21.120.932/0.9
Mn = 23,467,702 N/mm

$$Rn = \frac{Mn}{bd^2}$$

$$Rn = \frac{23.467.702}{1000.92^2}$$

$$Rn = 2,77$$

$$m = \frac{fy}{0,85.f'c}$$

$$m = \frac{420}{0,85.25}$$

$$m = 19,76 \rho = \frac{1}{m}(1 - \sqrt{1 - \frac{2.m.Rn}{fy}}$$

$$\rho = \frac{1}{19,76}(1 - \sqrt{1 - \frac{2.19,76.2,77}{420}}$$

$$\rho = 0,00709$$

Based on table 24.4.3.2 of SNI 2847-2019 concerning the Ratio of shrinkage and minimum temperature thread reinforcement area to gross concrete cross-sectional area, it indicates that:

If, fy < 420 then ρmin 0.0020 and if, fy ≥ 420 then ρmin or 0.0014. $\frac{0,0018 \, x \, 420}{fy}$

While ρmax = 0.75.ρb with

$$\rho b = \frac{0,85 \times fc}{fy} \beta 1 \frac{600}{600 + 420}$$

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$$\rho b = \frac{0,85 \times 25}{420} 0,85 \frac{600}{600 + 420} = 0,025$$

Then ρmaks = 0.75.ρb = 0.75.0.025 = 0.019

So in this study, the ρmin used is 0.0014. Because ρmaks> ρ > ρmin, in this study ρ=0.00709 is used.

Ash = ρ.bd = 0.00709 x1000 x 96 = 652.28 mm^2

If 8 mm diameter reinforcement is used, reinforcement is required.

$$n = \frac{Asp}{Asd} = \frac{652,8}{1/4\pi.2.8^2} = 6,2 \approx 7\ buah$$

So 7 D8 reinforcements are used at a distance of every 1m, so the reinforcement distance is S=1000/7 = 150 mm.≈

Reinforcement spacing is sought based on SNI 2847-2019 Article 7.7.2.3 maximum spacing for threaded reinforcement must be less than *3h*or*450mm.* So, the maximum spacing in this study is 3.(120mm) = 460 mm or 450 mm. The spacing used in this study is = 150 mm safe to use.

control:

Asd > Asp

$$\frac{1}{4} \times \pi \times d^2 \times \left(\frac{1000}{s}\right) > 652,28\ mm^2$$

$$\frac{1}{4} \times 3,14 \times (8^2) \times \left(\frac{1000}{150}\right) > 652,28\ mm^2$$

$$670,4\ mm^2 > 652,28\ mm^2\ (Aman).$$

Because the axle used is larger than the axle required, the reinforcement used, namely 2ø8 – 200, is safe to use.

Shear reinforcement in reinforced concrete floor slabs is the process of inserting reinforcing steel into concrete to increase its strength against shear forces. Shear force is a force that acts parallel to the surface of the material, which can cause shifting or separation between parts of the material.

Mn = Mu/Ø

Mn = 15.086.380 /0.9

Mn = 16,762,644 N/mm

$$Rn = \frac{Mn}{bd^2}$$

$$Rn = \frac{16.762.644}{1000.92^2}$$

$$Rn = 1,98$$

$$m = \frac{fy}{0,85.f'c} = \frac{420}{0,85.25} = 19,76$$

$$\rho = \frac{1}{m}(1 - \sqrt{1 - \frac{2.m.Rn}{fy}}$$

$$\rho = \frac{1}{19,76}(1 - \sqrt{1 - \frac{2.19,76.1,98}{420}}$$

$$\rho = 0,00495$$

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Based on table 24.4.3.2 of SNI 2847-2019 concerning the Ratio of shrinkage and minimum temperature thread reinforcement area to gross concrete cross-sectional area, it indicates that:

If, fy < 420 then ρmin 0.0020 and if, fy ≥ 420 then ρmin or 0.0014. $\frac{0,0018\ x\ 420}{fy}$

While ρmax = 0.75.ρb with

$$\rho b = \frac{0,85 \times fc}{fy} \beta 1 \frac{600}{600 + 420}$$

$$\rho b = \frac{0,85 \times 25}{420} 0,85 \frac{600}{600 + 420} = 0,025$$

Then ρmaks = 0.75.ρb = 0.75.0.025 = 0.019

So in this study, the ρmin used is 0.0014. Because ρmaks> ρ > ρmin, in this study, ρ= is used. $0,00495$

Ash = ρ.bd = 0.00495 x1000 x 92 = 455.4 mm^2

If 8mm diameter reinforcement is used, reinforcement is needed.

$$n = \frac{Asp}{Asd} = \frac{455,4}{1/4\pi.2.8^2} = 4,5 \approx 5 \text{ buah}$$

So 5 pieces of 2D8 reinforcement are used at a distance of every 1m, so that the reinforcement distance is S=1000/5 = 200 mm. ≈

Reinforcement spacing is sought based on SNI 2847-2019 Article 7.7.2.3 maximum spacing for threaded reinforcement must be less than *3h* or *450mm.*

So, the maximum spacing in this study is 3.(120mm) = 460 mm or 450 mm. The spacing used in this study is = 200 mm safe to use.

control:

Asd > Asp

$$\frac{1}{4} \times \pi \times d^2 \times \left(\frac{1000}{s}\right) > 455,4\ mm^2$$

$$\frac{1}{4} \times 3,14 \times (2.8^2) \times \left(\frac{1000}{200}\right) > 455,4\ mm^2$$

$$502,4\ mm^2 > 455,4\ mm^2\ (\text{Aman})$$

Long term deflection (δ f)

The additional long-term deflection due to shrinkage and creep for flexible components can be calculated as the product of the instantaneous deflection caused by the constant load by a factor $\lambda\Delta$.

$\lambda\Delta$ = ξ 1 + 50xρ

$$\lambda\Delta = \xi \frac{\xi}{1 + 50\ x\ \rho} = = 1.57 \frac{2}{1 + 50\ x\ 0,00544}$$

So,

$$\delta\ f = \frac{\lambda\Delta 5.Qu.l^4}{384.Ec.Ie}$$

$$\delta\ f = \frac{1,57\ x\ 5 \times 15,428 \times (4000)^4}{384 \times 23500 \times 6,14x\ 10^8} = 4.08\ mm$$

δtot = 2.6 + 4.08 = 6.68 mm

Based on SNI 2847 – 2019 table 2.18 the calculation of maximum permissible deflection is as follows:

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l/240 = 4000/240 = 16.6 mm

so that δtot = 5.9 mm < δijin = 16.6 mm, then the thickness of the plate and reinforcement used is safe for use.

Table 14. Research results

Plan reinforcement	Reinforcement research		Reinforcement efficiency	
	2Ø8 –150 (Flexible)	2Ø8- 200 (Slide)	2Ø8 –200 (Flexible)	2Ø8- 250 (Slide)
As needed (mm2)	652.28	455.4	652.28	455.4
Wear (mm2)	670.4	502.4	502.4	401.92
Allowable deflection (mm)	6.68	6.68	11.7	11.7
Total deflection (mm)	16.6	16.6	16.6	16.6
ϕVc (N/mm)	58650	58650	58650	58650
Vu (N/mm)	32823.07	32823.07	32823.07	32823.07

Source: Research results

CONCLUSION

Based on the results of the analysis of the floor plate calculations at the Irian Supermarket Setiabudi Medan Building, several things were concluded as follows: The thickness of the floor slab used in this project is 120 mm and the reinforcement used is 2ø8 – 150 (2 Layers) for the lantern reinforcement and 2ø8 – 200 (2 Layers) for the shear reinforcement which is safe and in accordance with SNI 2847-2019 regulations. The efficiency of the floor slab reinforcement plate was not carried out because the As used value was smaller than the As required for both flexural reinforcement and shear reinforcement.

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