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Structural Analysis of the Pasar Minggu Subdistrict Health Center Building in South Jakarta City

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Abstract
In light of the rising incidence of natural disasters, it is crucial to ensure that all buildings, particularly those serving public functions, are capable of withstanding a range of potential loads. This study examines the structural integrity of the Pasar Minggu Subdistrict Health Center in South Jakarta through analysis using ETABS software, deriving internal forces from the facility's working drawings in alignment with the requirements of SNI 2847:2019, SNI 1726:2019, and SNI 1727:2020. Employing a quantitative methodology via ETABS V18.1.1, the analysis incorporates primary data gathered from on-site measurements alongside secondary data sourced from relevant literature and established design standards. Key steps encompass structural modeling, load determination, and an assessment of the capacity of critical components, including columns, beams, and slabs. The findings indicate that the majority of the building's structural elements satisfy the prescribed strength criteria. Nonetheless, columns K4 on the Dak floor and K6 on the Dak staircase and terrace at the first-floor level fall short of the Weak Beam-Column Strength (SBLB) requirements, underscoring the necessity for targeted design enhancements and reinforcement measures. These outcomes underscore the value of thorough structural evaluations in architectural planning. The study further offers guidance on refinements to bolster the structure's safety and longevity, while stressing adherence to prevailing regulations in infrastructure projects.
Keywords: Development, Analysis, Branch Office, Building Structure, Seismic

INTRODUCTION

Community health centers (Puskesmas) are very important health care facilities and play a major role in improving public welfare (Hartini, 2025; Kadar, Ardillah, Puspitha, & Erfina, 2022). The provision of these health services is the responsibility of the government, as it is directly related to the results of Public Health degrees. Puskesmas operate through an integrated service system supported by adequate facilities, where the effectiveness of services must be in harmony with the availability and quality of these facilities (Amimr & Sari, 2024). Therefore, the proper and optimal development of Puskesmas can contribute significantly to improving the overall welfare of the community.

In Indonesia, deficiencies in the implementation of structural design and safety requirements are still frequently observed in the development of health facilities (Machfudiyanto, Kim, Latief, Rachmawati, & Laksono, 2023). Such conditions pose a high risk to structural safety, especially in areas with high seismic vulnerability, including South Jakarta, which is located in an active earthquake zone. Inadequate structural assessment and evaluation of seismic performance can increase the likelihood of structural damage, potentially resulting in major economic consequences and, in severe situations, loss of life (Ahmed, Shahzada, & Fahad, 2021).

A number of previous studies have highlighted the importance of structural analysis in the design and evaluation of hospital buildings (Jaušovec & Gabrovec, 2023). For Example, Hotma L. Purba (2014) conducted a case study on a hospital building in Palembang with a total floor area of 600 m2. Another study by Arza Reka Struktur Group (2014) examined the structural design planning of an eight-story office building using a Special Moment Resisting Frame (SRPMK) system located in earthquake zone 3 with moderate soil conditions. Similarly, Arief Firmanto (2018) analyzed and designed a four-story apartment building, with results showing the need for structural improvements to improve the building's safety. Furthermore, Fathur Rohman (2019) in a study on the structural planning of the Tuparev Hotel building in Cirebon, emphasized the importance of structural design and calculations that comply with applicable regulations to ensure the fulfillment of building construction requirements (Nazarudin, Rizkyansyah, Nurokhim, & Sumarman, 2025).

Indonesia is characterized by high levels of seismic activity and exposure to natural hazards, so the structural assessment of health facilities is a critical research concern (Jena, Pradhan, Beydoun, Alamri, & Sofyan, 2020). As the incidence of such disasters increases, it becomes increasingly important to verify that public service buildings are properly designed and assessed to withstand the various structural loads they may experience.

This study proposes an analytical approach using ETABS software to evaluate the structural performance of a Puskesmas building located in Pasar Minggu Subdistrict, South Jakarta. Furthermore, the analysis results are compared with applicable national design standards, and recommendations for structural design improvements are provided to enhance overall safety and performance (Zameeruddin & Sangle, 2016).

This study is conducted to assess the structural performance of the Pasar Minggu Community Health Center building with reference to SNI 1726:2019 and SNI 2847:2019. The assessment focuses on determining the ability of the structural system to withstand the specified design loads while fulfilling the established safety requirements (Bahr, 2018; Grandt Jr, 2003). The outcomes of this research are anticipated to support the formulation of more effective infrastructure planning policies in Indonesia. In addition, the results are intended to provide a technical benchmark for designers, engineers, and relevant stakeholders in ensuring that healthcare facility construction adheres to current standards and achieves an acceptable level of structural safety (Firoozi & Firoozi, 2025).

RESEARCH METHODOLOGY

The research employed a quantitative approach, involving the collection and critical review of literature related to structural design obtained from textbooks, codes, and other relevant sources.

Identification of Research Problems

The initial stage of the study focuses on clearly formulating the research problem by systematically identifying the key issues that require further investigation. Clearly defining the research problem to systematically identify and describe the issues that need to be addressed, thereby enabling effective and efficient problem resolution (Smith & Shaw, 2019).

Data Collection

Data is classified into two categories based on how it is obtained:

Primary Data

Primary data is collected directly through methods such as observation, interviews, and research.

The observational data acquired in this study are summarized as follows:

a) Existing design documents, including architectural layouts and detailed drawings of structural components such as beams, columns, slabs, foundations, and stair elements.
b) Geotechnical investigation results obtained from soil testing at the building site.

Secondary Data

Secondary data for this study were gathered from various existing sources, including:

a) National design standards (SNI) adopted as the primary reference and guideline for the analysis.
b) Seismic response spectrum parameters used for earthquake-resistant structural design and seismic load evaluation.

c) Wind velocity data applied in the assessment of wind-induced loads acting on the structural system.
d) Supporting literature, including textbooks, peer-reviewed journals, and other relevant reference materials.

Load Specification and Verification

At this stage, the loads acting on the structural model are defined and applied within the ETABS software for analytical purposes. This process aims to evaluate the structural response to various potential actions, including environmental, climatic, and seismic loads (Salgado & Guner, 2021). Load calibration is conducted through verification and validation procedures to ensure that the defined load cases and combinations conform to the design assumptions and applicable specifications.

Structural System Modeling

Structural system modeling in the ETABS software is developed in accordance with applicable design standards and configured to closely represent the actual building conditions. This approach is intended to ensure accurate evaluation of the structural performance under the prescribed loading conditions.

Analysis of Structural Strength

Following the extraction of internal force results from the ETABS analysis, detailed hand calculations are carried out for key structural components, such as columns, beams, slabs, staircases, and foundation elements, in compliance with the most recent applicable design standards.

Research Conclusions

The final stage involves evaluating the analysis results to determine whether the assessed structural elements comply with the applicable standards and regulatory requirements. If the requirements are satisfied, a summary of the analysis results is prepared. Conversely, if the requirements are not met, appropriate recommendations are proposed to achieve adequate structural safety and compliance

RESULTS AND DISCUSSION

A. Description of the Structural Model

For the purpose of conducting a detailed structural assessment of the Pasar Minggu Subdistrict Health Center building in South Jakarta, ETABS version 18.1.1 was employed to construct a three-dimensional structural representation and to evaluate the internal forces generated by the defined load combinations.

Figure 1: ETABS-Based Structural Modeling

B. Building Characteristics

a) Building Function: Office use
b) Building Size and Height:

Table 1: Building Dimensions and Mass Distribution

No	Nama	Total Luas	Ketinggian	Massa (Ton)
1	Lantai 1	843,8	0	5585.41
2	Lantai 2	695,9	3,8	6522.952
3	Lantai 3	695,9	7,6	6794.989
4	Lantai 4	607,2	11,4	6515.266
5	Lantai 5	607,2	15,2	6499.918
6	Atap	607,2	19	5898.091
7	Dak Atap	126	22,8	704.4668

C. Dimensions of Structural Elements

Table 2: Dimensional Data of Beam Elements

Balok Lt. 1 (*Sloof*)		**Balok Lt. 2**		**Balok Lt. 3**		**Balok Lt. 4**	
Tipe	Dimensi mm	Tipe	Dimensi mm	Tipe	Dimensi mm	Tipe	Dimensi mm
TB1	300/500	B1	350/500	B1	350/500	B1	350/500
TB2	300/450	B2.1	250/400	B2.1	250/400	B2.1	250/400
TB3	250/400	B2.2	200/400	B2.2	200/400	B2.2	200/400
TB4	200/400	BK	300/400	BK	300/400	BK	300/400
TB5	200/300	B3.1	200/300	B3.1	200/300	B3.1	200/300
SL1	200/200	RB	150/200	RB	150/200	RB	150/200

Balok Lt. 5		**Balok Dak Atap**		**Balok Atap**		**Balok Atap**	
Tipe	Dimensi mm	Tipe	Dimensi	Tipe	Dimensi mm	Tipe	Dimensi mm
B1	350/500	B1	350/500	B1	350/500	B1	350/500
B2.1	250/400	B2.1	250/400	B2.1	250/400	B2.1	250/400
B2.2	200/400	B2.2	200/400	B2.2	200/400	B2.2	200/400
BK	300/400	BK	300/400	BK	300/400	BK	300/400
B3.1	200/300	B3.1	200/300	B3.1	200/300	B3.1	200/300
RB	150/200	RB	150/200	RB	150/200	RB	150/200

Table 3 : Column and Plate Dimension Data

Kolom			Pelat	
No.	Nama	Dimensi (cm)	Tipe	Tebal (mm)
1	K1	50X50	S1	200
2	K2	40X40	S2	150
3	K3	2SX40	S3	125
4	K3.A	35 X 35	S4	120
5	K4	30 X 30	S5	200
6	K5	25 X 25		
7	K6	20 X 20		

D. Structural Materials and Quality Specifications

Table 4 : Material Specifications and Quality

No.	Jenis	Bahan	Mutu
1	Kolom	Beton	Tekanan 25 Mpa
2	Balok	Beton	Tekanan 25 Mpa
3	Lempeng	Beton	Tekanan 25 Mpa
4	Pilecap	Beton	Tekanan 42 Mpa
5	Tulangan D > 10	Baja Ulir	Tekanan 420 Mpa
6	Tulangan D < 10	Baja Ulir	Tekanan 280 Mpa

RESULTS OF STRUCTURAL ANALYSIS

A. Beam Structural Analysis Results

Based on the analysis of all beam elements, it was found that the beams satisfy the required safety criteria and are considered structurally adequate (A. V Alekseytsev, Gaile, & Drukis, 2019). The evaluation included checks on material strength, shear capacity, as well as stress and strain distribution within the beams. The results indicate that all beams are capable of resisting the maximum design loads without experiencing structural failure or excessive deformation (Yıldırım et al., 2018). As a representative case, the beam with the largest bending moment is presented in the following analysis.

Table 5 : Example of Analysis of Beam B1X on Floor 2

Tipe	Dimensi		Frame		As Perlu ETABS	Manual				Tulangan Utama
	b	h				As Perlu	As Pakai	Mu	φMn	
	mm	mm			mm^2	mm^2	mm^2	kN-m	kN-m	
B1X	350	500	Tumpuan	Atas	907	502,3	1134,1	167,6	173,1	8 D16
				Bawah	789	567,1	850,6	12,0	146,6	6 D16
			Lapangan	Atas	492	502,3	850,6	43,3	146,6	6 D16
				Bawah	907	502,3	1134,1	167,6	173,1	8 D16

Table 6 : Analysis Results of Transverse Reinforcement for G1X Beam, 1st Floor mm

Tipe	Dimensi b (mm)	Dimensi h (mm)	Frame		Manual Av+t/s Perlu (mm^2/mm)	Manual Av+t/s Pakai (mm^2/mm)	Tulangan Geser
B1X	350	500	Tumpuan	Atas / Bawah	0,7	5,7	D10 -100
			Lapangan	Atas / Bawah	0,3	5,7	D10 -100

B. Column Structural Analysis Results

The evaluation of column elements indicates that, in general, the columns meet the prescribed strength and safety requirements. Nevertheless, certain columns were identified as not complying with the Strong Column–Weak Beam (SCWB) criterion, notably columns K3A and K6. As a representative case, the analysis results for column K4 are presented in the following table.

Table 7 : Analysis of Longitudinal Reinforcement for Column K4

Tipe	b (mm)	h (mm)	Frame	Kondisi	As Perlu ETABS (mm^2)	As Pakai Manual (mm^2)	Tulangan Utama	As/S Perlu (mm^2/mm)	As/S Pakai (mm^2/mm)	Tulangan Geser	Syarat SCWB
K4	300	300	Tumpuan	Lemah	1575	2268,2	12 D16	0,724	1,571	3D13 – 100	**NOT OK**
				Kuat				0,724	1,571	2D13 – 100	
			Lapangan	Lemah				0,000	1,571	2D10 – 100	
				Kuat				0,000	1,571	2D10 – 100	

Table 8 : Analysis of Longitudinal Reinforcement in Column K6

Tipe	b (mm)	h (mm)	Frame	Kondisi	As Perlu ETABS (mm^2)	As Pakai Manual (mm^2)	Tulangan Utama	As/S Perlu (mm^2/mm)	As/S Pakai (mm^2/mm)	Tulangan Geser	Syarat SCWB
K6	200	200	Tumpuan	Lemah	900	1134,1	4 D16	0,724	1,571	2D10 – 100	**NOT OK**
			Tumpuan	Kuat				0,724	1,571	2D10 – 100	
			Lapangan	Lemah				0,474	1,047	2D10 – 150	
			Lapangan	Kuat				1,770	1,047	2D10 – 150	

To mitigate the risk of structural inadequacy, strengthening measures are recommended for the affected columns by increasing the reinforcement ratio or adding longitudinal reinforcement (Anatoly Victorovich Alekseytsev & Kurchenko, 2023). In addition, increasing the cross-sectional dimensions of the columns is expected to improve their nominal moment capacity (Janwaen, Barros, & Costa, 2019). The proposed strengthening strategies, including recommendations for increasing reinforcement diameters, are summarized in the following table.

Table 9 : Summary of Recommendations Column Analysis

Tipe	Tulangan Utama lama	Tulangan baru (Jumlah Tulangan Ditambah) (1)	Tulangan baru (Diameter Diperbesar) (2)	Mn			SYARAT SCWB
				Mn kolom (1)	Mn kolom (2)	Mn Balok	
				2 Mn	2 Mn	1.2 * (Mn^-+Mn^+)	
K4	12 D16	16 D16	8 D22	483,8	268,5	509,05	OK
K6	4 D16	8 D16	8 D22	146.3	29,5	454,33	OK

C. Analysis Results of Plate

Based on the structural evaluation, all slab (plate) elements were verified to satisfy the required strength and safety criteria under the applied loading conditions. The analysis confirms that the plates are capable of performing as intended without experiencing excessive stress or deformation (Crook et al., 2020). An example of the analytical results for an SS-type slab is presented below.

Table 10 : Analysis of S5 Type Plate Samples

Tipe	Tebal (mm)	Arah	Frame	Mu (kNm)	φMn (kNm)	As Perlu (mm^2)	As Pakai (mm^2)	Tulangan
S5	200	Arah X	Lapangan bawah (m11)	17,5	41,1	360	785,4	D10 – 100
			Tumpuan atas (m11)	-19,2	41,1	360	785,4	D10 – 100
		Arah Y	Lapangan atas (m22)	15,0	38,2	360	785,4	D10 – 100
			Tumpuan bawah (m22)	-30,8	38,2	360	785,4	D10 – 100

D. Analysis Results of Staircase

The analysis results indicate that all staircase elements meet the required structural strength and safety requirements. The evaluation confirms that the stair components are capable of safely resisting the applied loads in accordance with the applicable design standards. An example of the analysis results for the T1 staircase is presented below.

Table 11 : Analysis of T1 Type Staircase Samples

<table>
<tr><th rowspan="3">TIPE</th><th rowspan="3" colspan="2">Frame</th><th>As</th><th>As</th><th rowspan="3">Cek</th><th rowspan="3">Tulangan</th></tr>
<tr><th>Perlu</th><th>Pakai</th></tr>
<tr><th>mm²</th><th>mm²</th></tr>
<tr><td rowspan="4">A</td><td rowspan="2">ARAH X</td><td>Tulangan Atas</td><td>440</td><td>1327,0</td><td>OK</td><td>D13 - 100</td></tr>
<tr><td>Tulangan Bawah</td><td>440</td><td>1327,0</td><td>OK</td><td>D13 - 100</td></tr>
<tr><td rowspan="2">ARAH Y</td><td>Tulangan Atas</td><td>264</td><td>393,0</td><td>OK</td><td>D10 - 200</td></tr>
<tr><td>Tulangan Bawah</td><td>264</td><td>393,0</td><td>OK</td><td>D10 - 200</td></tr>
<tr><td rowspan="4">B</td><td rowspan="2">ARAH X</td><td>Tulangan Atas</td><td>440</td><td>1327,0</td><td>OK</td><td>D13 - 100</td></tr>
<tr><td>Tulangan Bawah</td><td>440</td><td>1327,0</td><td>OK</td><td>D13 - 100</td></tr>
<tr><td rowspan="2">ARAH Y</td><td>Tulangan Atas</td><td>264</td><td>393,0</td><td>OK</td><td>D10 - 200</td></tr>
<tr><td>Tulangan Bawah</td><td>264</td><td>393,0</td><td>OK</td><td>D10 - 200</td></tr>
</table>

STRUCTURAL ANALYSIS RESULTS

A. Pile Capacity Analysis Results

Based on the pile capacity analysis, all pile elements are found to satisfy the required safety criteria and are therefore considered structurally adequate. The detailed analysis results are presented in the following table.

Table 12 : Results of Pile Bearing Capacity Analysis

Tipe	Pu total (kN)	Effisiensi	N	Qa (kN)	1 TP Eff. (kN)	Eff Grup (kN)	Pu total < Eff. Grup TP
TP 1	429,3	1,000	1	1013,8	1013,8	1013,8	YES
TP 2	691,2	0,898	2	1013,8	910,0	1820,0	YES
TP 4	1518,8	0,795	4	1013,8	806,1	3224,6	YES
TP 6	2007,3	0,761	6	1013,8	771,5	4629,2	YES

B. Results of Pilecap Structural Analysis

The analysis results demonstrate that all pilecap elements comply with the prescribed strength and safety requirements, indicating that the pilecaps are structurally adequate under the applied loading conditions. A summary of the detailed analytical results is provided in the following table.

Table 13 : Analysis of Pilecap Reinforcement

TIPE	DIMENSI (m)			Jumlah PILE	Tul. Lentur		Tul. Susut	
	P	L	T		Arah X	Arah Y	Arah X	Arah Y
TP 1	1,0	1,0	0,6	1	D16 - 150	D16 - 150	D13 - 150	D13 - 150
TP 2	1,0	2,0	0,6	2	D19 - 150	D16 - 150	D13 - 150	D13 - 150
TP 4	1,8	1,8	0,6	4	D19 - 150	D16 - 150	D13 - 150	D13 - 150
TP 6	2,2	1,8	0,6	6	D19 - 150	D16 - 150	D13 - 150	D13 - 150

CONCLUSION

The structural performance evaluation of the Pasar Minggu Subdistrict Health Center building in South Jakarta was conducted in compliance with SNI 2847:2019, SNI 1726:2019, and SNI 1727:2020. The analysis results indicate that the overall structural system is capable of resisting the prescribed design loads. Structural elements such as beams, slabs, foundations, pile caps, and piles were found to satisfy the applicable strength and safety requirements.

However, several column elements, specifically columns K4 and K6, did do not satisfy the Strong Column–Weak Beam (SCWB) requirement criterion, as the nominal moment capacity of the columns was lower than that of the corresponding beams. To improve seismic performance and ensure compliance with design standards, it is recommended that these columns be strengthened through additional reinforcement or by increasing their cross-sectional dimensions, with priority given to increasing the column dimensions.

Overall, this study highlights the importance of comprehensive structural evaluation for healthcare facilities in seismic regions and provides practical insights for improving structural safety in accordance with current design standards.

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