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# Structural Analysis of The BRI Branch Office in Kesambi Sub-District Cirebon City

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**KEYWORDS:**
Development, Analysis, Branch Office, Building Structure, Seismic.

**ABSTRACT**

Safe and standardized infrastructure development is an important factor in supporting economic growth, especially in disaster-prone areas such as Cirebon. This research aims to analyze the structural strength of the BRI branch office building in Kesambi, Cirebon, in accordance with SNI 2847:2019, SNI 1726:2019, and SNI 1727:2020 regulations. This research uses a quantitative approach with ETABS V18.1.1 software to conduct structural analysis. The data used includes primary data from field measurements and secondary data from literature and applicable design standards. The analysis process includes structural modeling, load calculation, and strength evaluation of structural elements such as columns, beams, and slabs. The analysis results show that most of the building's structural elements meet the established strength standards. However, columns K1C, K2, and KT3 did not meet the Strong Column Weak Beam (SCWB) criteria, indicating the need for improvement in the design and strengthening of these elements. These findings indicate the importance of applying comprehensive structural analysis in the planning of banking buildings. The research also provides recommendations for design improvements to enhance the safety and structural durability of the building, and emphasizes the need for compliance with applicable regulations in infrastructure development. This study concludes that the BRI branch office building in Kesambi, Cirebon, is generally safe for use, but there are some elements that require more attention to ensure structural safety.

## INTRODUCTION

Infrastructure development is one of the key factors in advancing a country's economy (Amarachi, 2024). According to a World Bank report, investment in infrastructure can increase a region's productivity and competitiveness, and reduce social and economic inequality (Crescenzi et al., 2016; Dang & Pheng, 2015; Palei, 2015). However, in many countries, including Indonesia, the challenge of planning and managing safe and sustainable infrastructure remains a pressing issue.

In Indonesia, particularly in the context of the construction of banking buildings, many buildings do not fully comply with established structural standards (Chandel et al., 2016; Mutiara et al., 2019). This potentially results in high safety risks, especially in disaster-prone areas, such as Cirebon, which is located in a seismic zone. The absence of a comprehensive structural analysis can lead to economic losses and even loss of life.

Several previous studies have discussed the importance of building structural analysis in the context of banking and public buildings (Shen et al., 2016). For example, a study by Abdillah (2022) showed that many school buildings and public facilities in Bandung do not meet structural safety requirements. Other studies by Ishyanovita (2023) examined the design of hotel structures focusing on earthquake resistance, as well as Roesdiana (2022) who analyzed the structure of flats in Pangalengan with results showing the need for structural improvements for better safety. In addition, research by Wicaksono et al. (2024) on the planning of multi-storey buildings in Jepara also highlighted the importance of adherence to national standards in structural design.

Given the high risk of earthquakes and natural disasters in Indonesia, this research is essential to identify and analyze the structural strength of banking buildings (Marlina et al., 2024; Pribadi et al., 2021). With the increasing frequency of disasters, it is important to ensure that any building, especially those used for public services, can withstand the various loads that may occur.

This research offers a new approach by using ETABS software to analyze the structural strength of the BRI branch office in Kesambi, Cirebon. In addition, this study will compare the analysis results with applicable national standards, as well as provide recommendations for safer design improvements.

The purpose of this study is to analyze the structural strength of the BRI building in Cirebon based on SNI 1726:2019 and SNI 2847:2019. This research aims to ensure that the building structure can support the expected loads and meet the established safety criteria. The results of this research are expected to contribute significantly to the development of better infrastructure planning policies in Indonesia. In addition, this research can be a reference for designers, engineers, and other stakeholders in ensuring that the construction of banking buildings in Indonesia is safe and in accordance with applicable standards.

## RESEARCH METHODS

The research method used is a quantitative approach, which involves collecting and studying literature related to the design obtained from books and other sources.

A. Problem Identification Stage

The problem identification stage involves defining the problem with the aim of recognizing and detailing the issues that need to be resolved so that they can be effectively and efficiently addressed.

B. Data Collection

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

1. Primary Data

Primary data is collected directly through methods such as observation, interviews, and research. From the observations, the following data is obtained :

a) Existing drawings including floor plans, detailed drawings of beams, columns, slabs, foundations, and stairs.
b) Soil testing data from the site of the building.

2. Secondary Data

Secondary data is obtained from existing sources, including:

a) SNI design regulations, which are used as the basis or guideline for the research,
b) Response spectrum data for designing earthquake strength for structural analysis against seismic forces,
c) Wind speed data for designing wind forces acting on the structure for structural strength analysis,

d) Literature such as books, journals, and other reference sources.

C. Loading Design and Load Calibration

In this stage, the loads acting on the structural model for analysis in the ETABS software will be planned. This is done to analyze the structural strength against potential loads from environmental influences, weather, or disasters. Load calibration involves verifying and testing to ensure that the planned and applied loads meet the design and specifications.

D. Structural Modeling

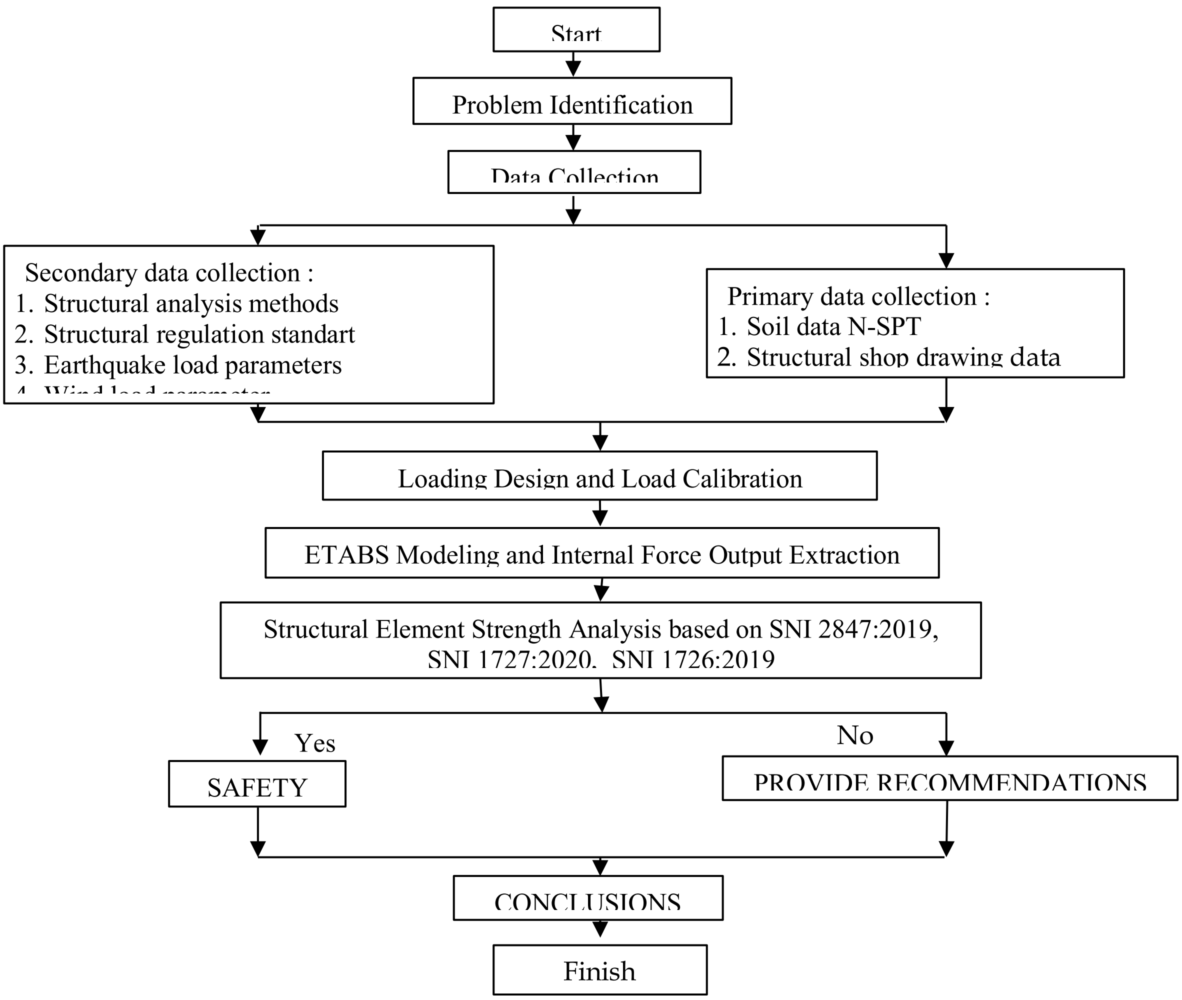
Structural modeling in the ETABS application must adhere to applicable standards and be as close as possible to the actual building. This is done to accurately analyze the structural performance against the planned loads.

E. Structural Strength Analysis

After obtaining the internal force output from the ETABS analysis, the next step is to perform a manual calculation of structural elements such as columns, beams, slabs, stairs, and foundations, based on the latest regulations.

F. Conclusion

The final step involves checking the analysis results to determine if the analyzed structural elements meet the required standards and regulations. If the requirements are met, the next stage is preparing a summary of the analysis results. If the requirements are not met, recommendations or suggestions for achieving a safe structural analysis will be provided.

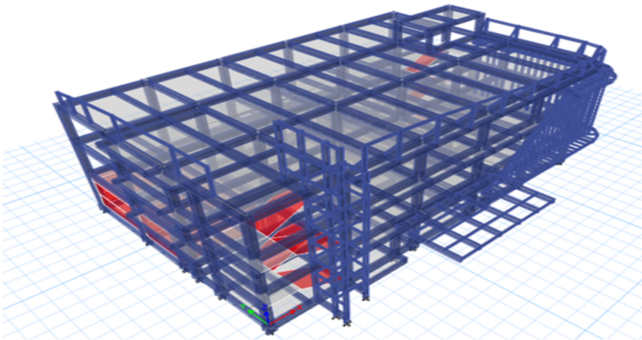



**Picture 1. Flowchart**

## RESULTS AND DISCUSSION

### Structural Modeling

A. To facilitate the structural analysis of the BRI Branch Office Building in Kesambi District, Cirebon City, the ETABS v.18.1.1 software application is used to model the structure in 3D and calculate the internal forces resulting from load combinations.



**Picture 2. Structural Modeling in ETABS**

B. Building Specifications

a) Building Function: Office

b) Building Area and Elevation :

**Table 1. Building Area, Elevation, and Mass**

| No. | Name | Total Area | Elevasion | Mass (Ton) |
|---|---|---|---|---|
| 1 | Floor 1 | 574,2 | 0 | 660,7 |
| 2 | Floor 2 | 568,3 | 4,5 | 642,6 |
| 3 | Floor 3 | 568,3 | 8,5 | 580,6 |
| 4 | Roof | 595,8 | 12,5 | 524,6 |

C. Structural Element Dimensions

**Table 2. Beam Element Dimension Data**

| Floor 1(*Sloof*) | | Floor 2 | | Floor 3 | | Roof Beams | |
|---|---|---|---|---|---|---|---|
| Type | Dimension (mm) | Type | Dimension (mm) | Type | Dimension (mm) | Type | Dimension (mm) |
| G1X | 350/500 | G1X | 350/500 | G1X | 350/500 | G1X | 350/500 |
| G2X | 300/500 | G2X | 300/500 | G2X | 300/500 | G2X | 300/500 |
| G3X | 250/500 | G3X | 250/500 | G3X | 250/500 | G3X | 300/400 |
| G4X | 400/600 | G4X | 300/400 | G4X | 300/400 | G4X | 400/600 |
| G5X | 350/600 | G5X | 400/600 | G5X | 400/600 | G5X | 350/600 |
| B1X | 200/400 | G6X | 350/600 | G6X | 350/600 | B1X | 250/400 |
| G1Y | 300/500 | G7X | 300/500 | G7X | 300/500 | B2X | 400/600 |
| G2Y | 300/600 | B1X | 250/400 | B1X | 250/400 | B3X | 250/500 |
| G3Y | 300/400 | B2X | 200/400 | B2X | 200/400 | B4X | 250/450 |
| G4Y | 400/600 | G1Y | 300/500 | B3X | 250/400 | G1Y | 300/500 |
| B1Y | 250/450 | G2Y | 300/600 | B4X | 250/450 | G2Y | 300/600 |
| B2Y | 250/500 | G3Y | 300/400 | G1Y | 300/500 | G3Y | 350/500 |
| B3Y | 250/500 | B1Y | 250/450 | G2Y | 300/600 | G4Y | 350/600 |
| Information : | | B2Y | 250/500 | G3Y | 300/400 | G5Y | 300/400 |
| G = main beam | | B3Y | 250/500 | G4Y | 300/600 | G6Y | 300/600 |
| B = secondary | | B4Y | 250/400 | B1Y | 250/450 | B1Y | 250/450 |
| beam | | B5Y | 200/400 | B2Y | 250/500 | B2Y | 250/500 |
| X = X Direction | | B6Y | 250/500 | B3Y | 250/500 | B3Y | 250/400 |

| Floor 1(*Sloof*) | | Floor 2 | | Floor 3 | | Roof Beams | |
|---|---|---|---|---|---|---|---|
| Type | Dimension (mm) | Type | Dimension (mm) | Type | Dimension (mm) | Type | Dimension (mm) |
| Y = Y Direction | | | | B4Y | 250/400 | B4Y | 400/600 |
| | | | | B5Y | 200/400 | B5Y | 250/500 |
| | | | | B6Y | 250/500 | G1X' | 300/400 |
| | | | | B7Y | 250/600 | G1Y' | 250/400 |
| | | | | B8Y | 250/500 | B1Y' | 250/400 |

**Table 3. Column and Slab Dimension Data**

| Column | | | Slab | |
|---|---|---|---|---|
| No. | Name | Dimension (cm) | Type | Thickness (mm) |
| 1 | K1A | 45 X 45 | S1 | 200 |
| 2 | K1B | 45 X 45 | S2 | 150 |
| 3 | K1C | 45 X 45 | S3 | 125 |
| 4 | K2 | 40 X 40 | S4 | 120 |
| 5 | KT1 | 35 X 45 | S5 | 200 |
| 6 | KT2 | 35 X 45 | | |
| 7 | KT3 | 30 X 30 | | |

A. Material and Structural Quality Specifications

**Table 4. Material and Quality Specifications**

| No. | Type | Material | Quality |
|---|---|---|---|
| 1 | Column | Concrete | 30 MPa |
| 2 | Beam | Concrete | 30 MPa |
| 3 | Slab | Concrete | 30 MPa |
| 4 | Pilecap | Concrete | 35 MPa |
| 5 | Reinforcement D ≥ 10 | Ribbed Steel | 420 MPa |
| 6 | Reinforcement D < 10 | Ribbed Steel | 280 MPa |

## Results of Structural Analysis

A. Beam Analysis Results

Based on the analysis of all beams, it was found that all beams are deemed safe for use. The analysis includes evaluations of material strength, shear resistance, and stress and strain distribution in the beams (Marí et al., 2015; Ombres, 2015). After careful calculations, it was determined that all beams can withstand the maximum planned load without experiencing structural failure or excessive deformation (Stylianidis et al., 2016). For beam analysis results, a sample of the beam with the largest moment is presented as follows :

**Table 5. Sample Beam Analysis G1X Floor 1**

| Dimension | | Frame | | As min ETABS | Calculation | | | | Long. Rebar |
|---|---|---|---|---|---|---|---|---|---|
| b | h | | | | As min | As used | Mu | ΦMn | |
| mm | mm | | | $mm^2$ | $mm^2$ | $mm^2$ | kN-m | kN-m | |
| 350 | 500 | Support | Top | 1042 | 502,3 | 1134,1 | 167,6 | 173,1 | 4 D19 |
| | | | Bottom | 517 | 567,1 | 850,6 | 12,0 | 146,6 | 3 D19 |
| | | Field | Top | 333 | 502,3 | 850,6 | 43,3 | 146,6 | 3 D19 |
| | | | Bottom | 976 | 502,3 | 1134,1 | 139,0 | 173,1 | 4 D19 |

**Table 6. Analysis Results of Transversal Reinforcement for Beam G1X Floor 1**

| Type | Dimension b (mm) | Dimension h (mm) | Frame | Calculation Av+t/s Min (mm²/mm) | Calculation Av+t/s Used (mm²/mm) | Transv. Rebar |
|---|---|---|---|---|---|---|
| G1X | 350 | 500 | Support | 0,7 | 5,7 | D10-100 |
| | | | Field | 0,3 | 5,7 | D10-100 |

B. Column Analysis Results

Based on the analysis of all columns, it was found that all columns are deemed safe for use. However, some columns do not meet the Strong Column Weak Beam (SCWB) criteria, specifically columns K2, K1C, and KT3. A sample analysis of column K1C is presented in the following table :

**Table 7. Longitudinal Reinforcement Analysis of Column K1C**

| Dimension b (mm) | Dimension h (mm) | Frame | | As min ETABS (mm²) | Calculation As Used (mm²) | Longit. Rebar |
|---|---|---|---|---|---|---|
| 450 | 450 | Support | Weak | 2025 | 2268,2 | 8 D19 |
| | | | Strong | | | |
| | | Field | Weak | | | |
| | | | Strong | | | |

**Table 8. Longitudinal Reinforcement Analysis of Column K1C**

| Frame | | Calculation As/S min (mm²/mm) | Calculation As/S Used (mm²/mm) | shear reinforcement | Check SCWB |
|---|---|---|---|---|---|
| Support | Weak | 0,493 | 3,982 | 3D13 - 100 | NOT OK |
| | Strong | 0,493 | 3,982 | 3D13 - 100 | |
| Field | Weak | 0,000 | 1,571 | 3D10 - 150 | |
| | Strong | 0,000 | 1,571 | 3D10 - 150 | |

To minimize potential structural failures, it is recommended to increase the diameter or add reinforcement to these columns. Additionally, increasing the column cross-sectional dimensions can enhance the column's nominal moment strength. Recommendations are summarized in the following table, with suggestions for increasing the reinforcement diameter :

**Table 9. Summary of Column Analysis Recommendations**

| Type | Old main Reinforc. | New Reinf. (number of Reinf. Added) (1) | New Reinf. (Enlarged Diameter) (2) | Mn Column (1) 2 Mn | Mn Column (2) 2 Mn | Mn Beam 1.2 * ($Mn^-$+$Mn^+$) | Check SCWB |
|---|---|---|---|---|---|---|---|
| K1C | 8 D19 | 12 D19 | 8 D22 | 521,8 | 565,4 | 509,05 | OK |
| K2 | 8 D19 | 12 D19 | 8 D22 | 469,6 | 447,5 | 454,33 | OK |
| KT3 | 4 D19 | 8 D19 | 4 D22 | 203,4 | 149,3 | 143,54 | OK |

C. Slab Analysis Results

Based on the analysis of all slabs, it was found that all slab elements are deemed safe for use. A sample analysis of slab type S5 is presented as follows :

**Table 10. Sample Analysis of Slab Type S5**

| Thickness (mm) | Frame | | Mu | φMn | As Min | As Used | Reinforc. |
|---|---|---|---|---|---|---|---|
| | | | kNm | kNm | $mm^2$ | $mm^2$ | |
| 200 | X Direc. | Bottom Field (m11) | 17,5 | 41,1 | 360 | 785,4 | D10 - 100 |
| | | Top Support (m11) | -19,2 | 41,1 | 360 | 785,4 | D10 - 100 |
| | Y Direc. | Top Field (m22) | 15,0 | 38,2 | 360 | 785,4 | D10 - 100 |
| | | Bottom Support (m22) | -30,8 | 38,2 | 360 | 785,4 | D10 - 100 |

D. Stair Analysis Results

Based on the analysis of all stairs, it was found that all stair elements are deemed safe for use. A sample analysis of stair type T1 A is presented as follows :

**Table 11. Sample Analysis of Stair Type T1 A**

| Frame | | As Min | As Used | Check | Reinforc. |
|---|---|---|---|---|---|
| | | $mm^2$ | $mm^2$ | | |
| X Direc. | Top Reinforc. | 440 | 1327,0 | OK | D13 - 100 |
| | Bottom Reinforc. | 440 | 1327,0 | OK | D13 - 100 |
| Y Direc. | Top Reinforc. | 264 | 393,0 | OK | D10 - 200 |
| | Bottom Reinforc. | 264 | 393,0 | OK | D10 - 200 |

**Results of Substructure Analysis**

A. Pile Capacity Analysis Results

Based on the analysis of pile capacities, it was found that all pile elements are deemed safe for use. The analysis results are presented in the following table :

**Table 12. Pile Capacity Analysis Results**

| Type | Pu total | Efficiency | N | Qa | 1 TP Eff. | Group Eff. | Pu total < Group Eff. TP. |
|---|---|---|---|---|---|---|---|
| | kN | | | kN | kN | kN | |
| 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 3A | 1501,8 | 0,795 | 3 | 1013,8 | 806,1 | 2418,4 | YES |
| TP 3B | 993,1 | 0,863 | 3 | 1013,8 | 875,4 | 2626,1 | YES |
| TP 4 | 1518,8 | 0,795 | 4 | 1013,8 | 806,1 | 3224,6 | YES |
| TP 5A | 2045,0 | 0,828 | 5 | 1013,8 | 839,8 | 4199,0 | YES |
| TP 5B | 1126,6 | 0,761 | 5 | 1013,8 | 771,5 | 3857,7 | YES |
| TP 6 | 2007,3 | 0,761 | 6 | 1013,8 | 771,5 | 4629,2 | YES |
| TP 8 | 2726,6 | 0,744 | 8 | 1013,8 | 754,2 | 6033,9 | YES |

B. Pilecap Analysis Results

Based on the analysis of all pilecaps, it was found that all pilecap elements are deemed safe for use. The analysis results are presented in the following table :

**Table 13. Pilecap Reinforcement Analysis Results**

| TYPE | DIMENSION (m) | | | Number of PILE | Bending Reinforcement | | Shrinkage Reinforcement | |
|---|---|---|---|---|---|---|---|---|
| | P | L | T | | X Direc. | Y Direc. | X Direc. | Y Direc. |
| TP 1 | 0,8 | 0,8 | 0,8 | 1 | D16 - 150 | D16 - 150 | D16 - 150 | D16 - 150 |
| TP 2 | 2,0 | 0,8 | 0,8 | 2 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 3A | 2,0 | 1,85 | 0,8 | 3 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 3B | 3,2 | 0,8 | 0,8 | 3 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 4 | 2,0 | 2,0 | 0,8 | 4 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 5A | 2,5 | 2,5 | 0,8 | 5 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 5B | 2,8 | 2,0 | 0,8 | 5 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 6 | 3,2 | 2,0 | 0,8 | 6 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |
| TP 8 | 4,4 | 2,0 | 0,8 | 8 | D19 - 150 | D19 - 150 | D16 - 150 | D16 - 150 |

## CONCLUSION

The structural performance evaluation of the BRI Branch Office building in Kesambi District, Cirebon City, West Java, has been carried out in accordance with SNI 2847: 2019, SNI 1726: 2019, and SNI 1727: 2020 standards. All structures analyzed can support the planned load. However, there are several structural elements that do not meet the applicable regulatory standards, namely columns K1C, K2, and KT3 which do not meet the Strong Column Weak Beam (SCWB) criteria because the nominal strength of the column is less than the nominal strength of the beam. Therefore, columns that do not meet the SCWB criteria are recommended to add reinforcement or enlarge the diameter, with a higher recommendation for the enlarged diameter.

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