# Study of Procurement of Temporary Waste Shelter Building in the Green Campus Program of Ibn Khaldun University, Bogor

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## ABSTRACT

Waste is one of the factors of environmental damage, especially in campus areas that have a lot of waste generation. Waste is also one of the factors of environmental damage in campus areas because of lecture activities that trigger a lot of waste generation. Green Metric Universitas Indonesia is a green campus program to provide information regarding the conditions and policies of each university in the world in an effort to stop global climate change through one of the waste processing methods. The purpose of the study is to create the Ibn Khaldun University Bogor Campus as a green campus in Bogor City with supporting factors in the provision of a Temporary Shelter (TPS) for Ibn Khaldun University Bogor based on SNI 19-3964-1994, SNI 2847-2019 and SNI 1727-2020. The method used is collecting primary data on land measurements, collecting waste generation data, data on the number of academics at Ibn Khaldun University Bogor and the results of interviews with the Bogor City Environmental Service to then conduct a structural analysis of the planned building using the ETABS V21.0.0 and SPColumn applications based on SNI 2847-2019 (Structural Concrete Requirements for Buildings). The results of the structural analysis of the planned dimensions of the Temporary Shelter (TPS) of Ibn Khaldun University Bogor are planned with a size of 17.5 meters x 6 meters using reinforced concrete material and with a roof covering structure using a concrete roof structure. The specifications of the TPS UIKA Bogor structural material use a concrete quality of 24.9 MPa, a yield strength of 400 MPa (threaded) and 300 MPa (plain) steel reinforcement. The column dimensions are K30x30 cm (bearing area with main reinforcement 4D14, shear reinforcement ø10-150 mm). The dimensions of the main beam are B20x40 cm (bearing area with 2D14 reinforcement, ø10-50 mm shear reinforcement and bearing area with 2D14 reinforcement, ø10-100 mm shear reinforcement). The dimensions of the child beam are B15x25 cm (bearing area with 2D14 reinforcement, ø10-200 mm shear reinforcement). The thickness of the concrete roof slab is 12 cm (two-layer and two-way reinforcement with ø12-100 mm. The output results of the structural analysis of the planned building are purple on the columns with a strength ratio of 0.90 to 0.95 and green on the beams with a ratio of 0.50 to 0.70 which indicates that the structure is safe enough for the working load. The planned budget for the TPS UIKA Bogor building is Rp 262,459,889.

**Keywords:** green campus; Temporary Shelter (TPS); structural analysis.

## INTRODUCTION

Based on data from the Ibn Khaldun University Bogor information system application, the number of students has almost doubled over the past 2 years, from 1920 people in 2022 to 2337 people in 2024. The increase in the number of students has caused several problems in the campus area, especially the problem of waste. Waste is one of the factors of environmental damage, especially in campus areas that have a lot of waste, so waste management is needed in the campus area. In implementing this concept, Indonesia has green campus criteria issued by the University of Indonesia and the Ministry of Research, Technology and Higher Education, so that an institution can be said to be a green campus if it applies the specified criteria. The implementation of this concept is planned for the Ibn Khaldun University Bogor Campus, which is a waste production area every day because the activities carried out on campus produce more waste through excessive material consumption. For this reason, the design and analysis of the TPS structure is needed so that

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the purpose of implementing a green campus, in addition to creating a green campus area, is also an initial stage of socialization to raise awareness and realize one of the indicators of implementing the green building concept, namely waste processing. Supporting factors for the realization of these goals require the provision of waste processing facilities in the form of TPS buildings, so that modeling and structural analysis calculations need to be carried out on the planned buildings, in order to ensure that the structure is suitable for use or not.

**Green campus**

The concept of a green campus was first popularized by the Association for the Advancement of Sustainability in Higher Education (AASHE) in the United States, which began identifying and reporting university sustainability efforts in 2005 by launching the Sustainability Tracking, Assessment & Rating System (STARS) which became a guideline for universities to measure their sustainability performance. In an effort to support the implementation of the green campus concept, the University of Indonesia established the UI Green Metric World University Rankings in 2010, which is an annual university ranking based on its environmental sustainability performance. In implementing this concept, Indonesia has green campus criteria issued by the University of Indonesia and the Ministry of Research, Technology and Higher Education, so that an institution can be said to be a green campus if it applies the specified criteria. 1. Green campus criteria from the University of Indonesia (UI) Green Metric World University

The green campus criteria based on the University of Indonesia (UI) Green Metric World University, (2019) have 6 (six) main categories, namely planning and infrastructure, energy and climate change, water, waste, transportation, and education and research.

2. Green campus criteria from the Ministry of Research, Technology and Higher Education

The green campus criteria of the Ministry of Education, Culture, Research, and Technology Number 13, (2022) sets out several criteria to be considered a green campus, namely energy and water management, waste management, green transportation, green buildings and infrastructure, education and research, and community involvement and outreach.

**Temporary shelter (TPS)**

Based on Law of the Republic of Indonesia Number 18 of 2008 in article 1, a Temporary Shelter is a place before waste is transported to a recycling, processing, and/or integrated waste processing site. Temporary shelters (TPS) are said to meet the requirements of Law of the Republic of Indonesia Number 18 of 2008 in article 46 if the construction design is able to protect waste from rain and sunlight, has lighting and ventilation, a waterproof ground floor, and housekeeping activities. Based on Law Number 18 of 2008 concerning Waste Management, it is stated that waste is the remains of daily human activities or natural processes in solid or semi-solid form in the form of organic or inorganic substances that are biodegradable or non-biodegradable which are considered no longer useful and are disposed of into the environment. Based on the Regulation of the Minister of Public Works of the Republic of Indonesia in 2013, waste processing technology can be as shown in table 1.

**Table 1.** Waste processing technology

| No | Processing Technology | Results |
|---|---|---|
| 1. | Physically | Waste size measurement<br>Compaction<br>Magnetic separation<br>Density<br>Optics |
| 2. | Chemically | Addition of chemicals or other materials to facilitate further processing |
| 3. | Biologically | Aerobic and/or anaerobic processing such as composting and/or biogasification |
| 4. | Thermically | Incineration<br>Pyrolysis |

| No | Processing Technology | Results |
|---|---|---|
| | | Gasification |
| 5. | Others | Fuel, namely refused derifed fuel (RDF) |

Based on the Regulation of the Minister of Public Works of the Republic of Indonesia in 2013, TPS must meet one of the following technical criteria:

1. TPS area up to 200 $m^2$.
2. Facilities are available to group waste into at least 5 (five) types of waste.
3. The type of construction of temporary waste containers is not a permanent container.
4. The area of the location and capacity are according to needs.
5. The location is easily accessible.
6. Does not pollute the environment.
7. Placement does not interfere with aesthetics and traffic.
8. Has a collection and transportation schedule.

**Design and Analysis of structure**

The Temporary Shelter (TPS) UIKA Bogor is designed using reinforced concrete material and with a roof covering structure using a concrete roof structure. Reinforced concrete is concrete that is reinforced with a certain area and number of reinforcements to obtain a cross-section response based on the assumption that both materials work together in resisting the forces that are applied (Nasution, 2009).

Structural analysis for reinforced concrete buildings is the process of determining the strength, stability and structural performance of the building. The rules of structural analysis aim to estimate the internal forces and deformations of the structural system and to ensure that the requirements for strength, serviceability, and stability in SNI 2847-2019 (Article 4.5, SNI 2847-2019) are met. The planning of reinforced concrete structures is based on the required strength calculated from the combination of factored loads and design strengths calculated as ØRn, where Ø is the strength reduction factor and Rn is the nominal strength. Columns are also the main structural elements that play the most important role in bearing lateral loads (especially earthquakes) on building structures (Lesmana, 2020). Beams can be interpreted as one of the elements of a portal structure with a horizontal span, while the portal is the main frame of the building structure, especially buildings. Concrete slabs are a structure that is generally used to channel dead loads and live loads to other main structures, such as beams and columns, so that concrete slabs are divided into two types, namely one-way slabs and two-way slabs. General requirements in SNI 2847-2019 Article 9.5.1, explain that for each combination of factored loads used, the design strength of the entire cross-section must meet Su≥U

## RESEARCH METHOD

This research was conducted on an empty land next to the basketball court as a Waste Disposal Site (TPS) of Ibn Khaldun University, Bogor, located on Jl. KH Sholeh Iskandar, KM 2, RT.01/RW.10, Kedung Badak Village, Tanah Sareal District, Bogor City with longitude coordinates of 106.79218323 and latitude coordinates of -6.55813626. The research implementation time began on May 8, 2024. The research location plan is shown in Figure 1.

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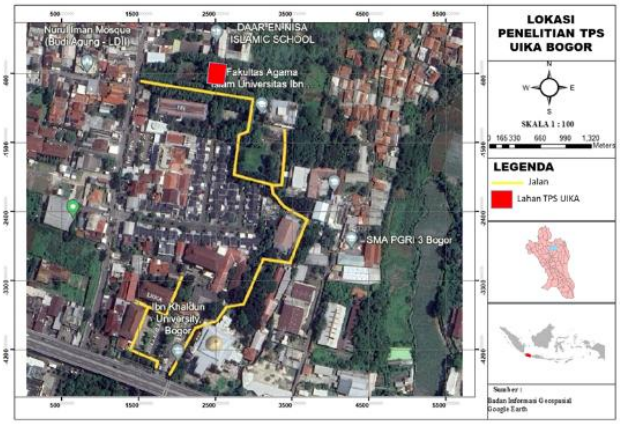


**Figure 1**. Research Location

The stages of this research are data collection used in the form of primary data and secondary data. Primary data includes data from land measurement results, building plan sketches and waste generation per week. Secondary data includes building structure literature such as SNI 2847: 2019 concerning (Structural Concrete Requirements for Buildings), SNI 1727: 2020 concerning (Minimum Design Loads and Related Criteria for Buildings and Other Structures) and Guidelines for House and Building Load Planning (PPURG) in 1987. This research is described in the research flow diagram shown in Figure 2.

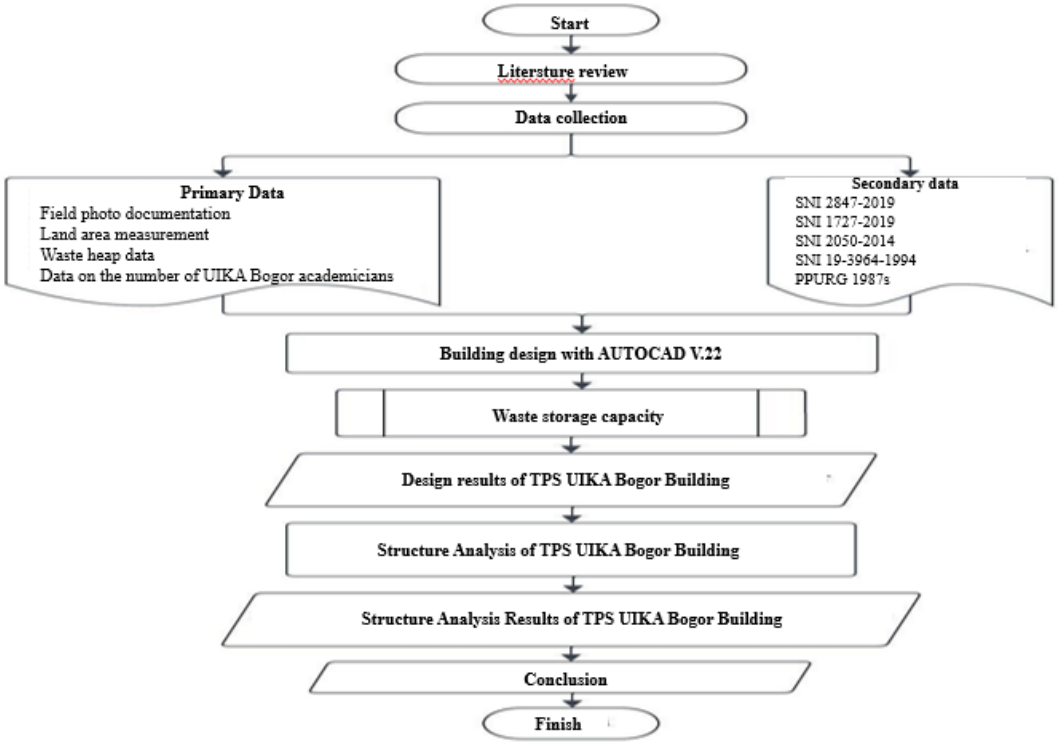


**Figure 2**. Research flowchart

## RESULTS AND DISCUSSION

### Waste Data Analysis

The waste used as a sample in this study came from the Ibn Khaldun University Bogor Campus environment which is a consequence of teaching and learning activities that take place almost every day. The collection process was carried out for ± 1 week, where the source of the waste was transported twice a day from the campus community, in this case lecturers, staff, and students. The calculation of the amount of waste generated is based on SNI 19-3964-1994 where the Ibn Khaldun University Bogor Campus is part of the division of the main waste group, namely non-housing. Waste generation is known by sampling for ± 7 consecutive days. Sampling was carried out 2 (two) times in 1 (one) day because disposal to the TPA was carried out 2 (two) times a week, namely on Wednesday and Saturday. The following are the results of the amount of waste generated based on the Bogor City Environmental Service shown in Table 2.

**Table 2.** Results of the amount of waste generated Based on the Bogor City Environmental Service

| Day- | Waste Type | Result (m3/day) | Kendaraan |
|---|---|---|---|
| 1. | Mixture | 0.932857143 | Arm Roll Truck |
| 2. | Mixture | 0.932857143 | |
| 3. | Mixture | 0.932857143 | |
| 4. | Mixture | 0.932857143 | |
| 5. | Mixture | 0.932857143 | Size 3.6 m x 2.0 m x 1.0 m |
| 6. | Mixture | 0.932857143 | |
| 7. | Mixture | 0.932857143 | |
| | **Total in 1 week** | **6.53** | |
| | **Total In 1 Month** | **26.12** | |

The data on the amount of waste generated is the result of waste that is still mixed in the truck container, the Environmental Service officers have not been able to carry out the waste sorting process because in addition to the large number of areas transported, time and place are still inadequate. Thus, the results of the calculation of waste generation and composition can be seen in Table 4.2. The percentage of calculation is based on the results of research (Anif Rizqianti Hariz, 2020) on the Study of Waste Generation and Composition in Waste Management Planning on Campus 2 Uin Walisongo. The results of the calculation are based on the conditions and location of the campus area shown in Table 4.2. After the results of waste generation are known, the next step is to select based on the components of each waste consisting of organic waste and inorganic waste. The results of the calculation are based on the conditions and location of the campus area shown in Table 3.

**Table 3**. Results of the amount of waste generated and Composition

| No | Waste Source | Waste Generation Volume (person/liter/day) | Waste Generation Weight (person/kg/day) | Percentage of Plastic Waste (9.19%) | Percentage of Paper Waste (9.05%) | Percentage of Other Waste (81.75%) |
|---|---|---|---|---|---|---|
| **1** | FKIP | 0.90 | 0.46 | 9.81 | 5.12 | 12.00 |
| **2** | FH | 1.74 | 0.90 | 18.99 | 9.90 | 23.22 |
| **3** | FEB | 0.52 | 0.27 | 5.70 | 2.98 | 6.98 |
| **4** | FAI | 0.35 | 0.18 | 3.84 | 2.00 | 4.69 |
| **5** | FTS | 0.43 | 0.22 | 4.73 | 2.47 | 5.78 |
| **6** | FIKES | 1.18 | 0.61 | 12.83 | 6.69 | 15.69 |
| **7** | PASCA SARJANA | 0.83 | 0.43 | 9.04 | 4.17 | 11.05 |
| | **Total** | **5.97** | **3.06** | **64.93** | **33.86** | **79.42** |

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Based on the data above in Table 3. it can be seen that the waste generated from lecture activities has a waste composition dominated by other waste (which has not been sorted) with a result of 79.42%. Based on these results, waste sorting is needed to reduce the waste entering the TPS. This activity can reduce the waste entering the TPS by 40.88%, then the remaining waste with economic value is sent to the recycling industry and the rest is sent to the Compost Bank.

**Design of the UIKA TPS Plan Building Structure**

In the planning of the UIKA Bogor TPS, it is necessary to analyze the structure by understanding the behavior of the loads that occur in order to obtain optimal, accurate planning and not cause structural failure by referring to secondary data, namely the literature SNI 2847: 2019, SNI 1727: 2020 and PPURG 1987. The land area provided by the Ibn Khaldun University Campus Bogor is 234 m2. This building is planned as a temporary shelter (TPS) with the hope of changing waste into a more stable form and not polluting the environment and reducing the amount of waste that must be dumped in the TPA (Final Processing Site). The land plan provided by the UIKA Bogor Campus and the existing condition of the UIKA Bogor TPS land are shown in Figures 3 and 4.

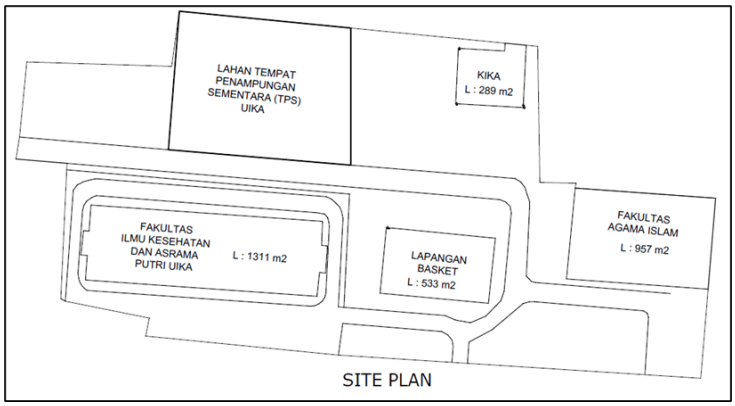


**Figure 3**. Site Plan of the planned TPS UIKA Bogor building

The existing condition of the TPS UIKA Bogor land is shown in Figure 4.

**Figure 4.** Existing condition of TPS UIKA Bogor land

The temporary shelter (TPS) is planned to be one floor equipped with facilities for cleaning staff to sort the waste generated on the Ibn Khaldun University Bogor campus. The plan for this one-story building is shown in Figure 5.

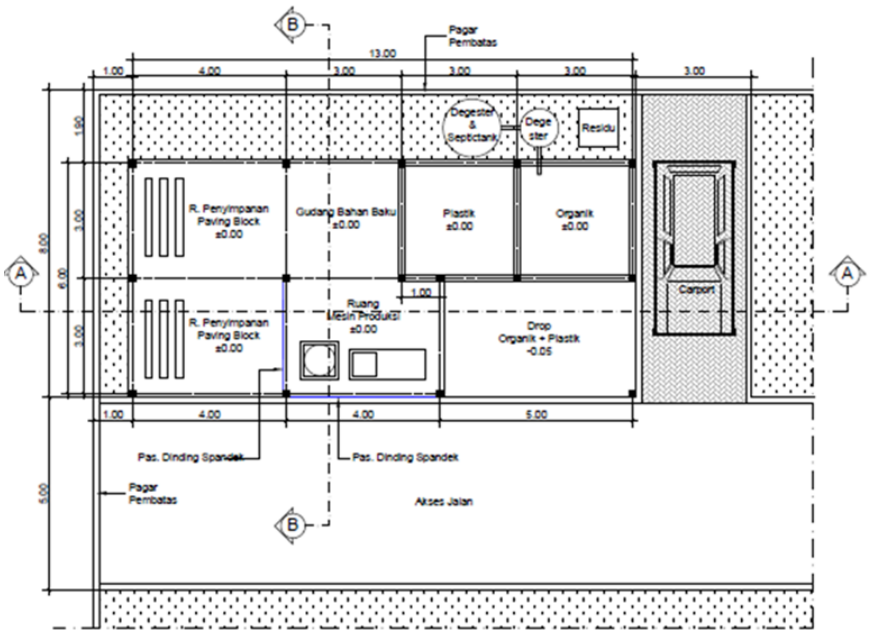


**Figure 5.** One-story building plan

The 3D design plan of the planned TPS UIKA Bogor building is shown in Figure 6.

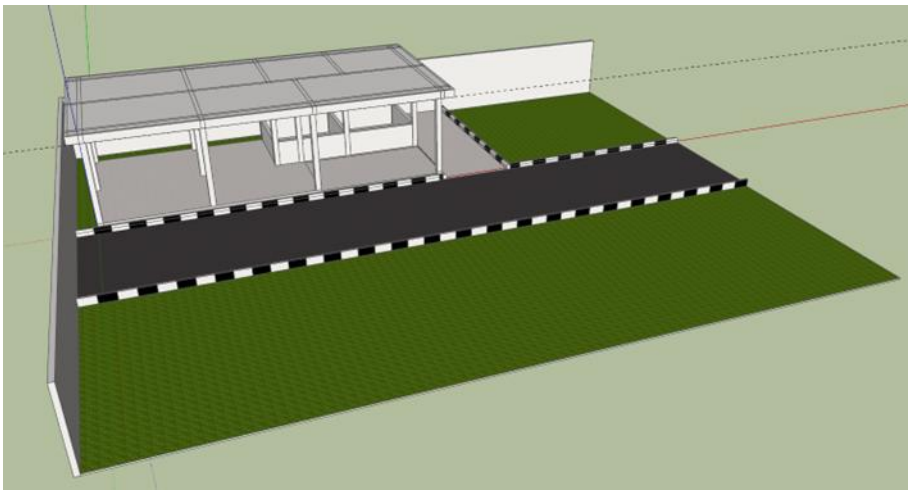

**Figure 6.** 3D design of the TPS UIKA Bogor plan

The land available at the TPS UIKA Bogor has the following planned facilities:

**Table 4**. Facilities of the planned building of the TPS UIKA Bogor

| No. | Room Facilities | Area (m2) |
|---|---|---|
| 1. | Storage room 1 | 12,00 |
| 2. | Storage room 2 | 12,00 |
| 3 | Raw material warehouse | 9,00 |
| 4 | Production machine room | 12,00 |
| 5. | Organic waste storage | 6,00 |
| 6. | Inorganic waste storage | 6,00 |
| 7. | Location for unloading mixed waste | 15,00 |
| 8. | Parking for garbage trucks | 24,00 |
| 9. | Disposal of waste and unused materials | 11,40 |

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| | | |
|---|---|---|
| 10. | Road access | 95,00 |

The planned building of TPS UIKA Bogor is planned with a 3meter x 3meter organic waste storage and a 3 x 3 m organic waste storage. The total capacity of the waste storage is shown in Table 5.

**Table 5.** Capacity of the total waste storage

| Types of waste counted | P | L | T | Volume of waste that can be accommodated (m3) |
|---|---|---|---|---|
| **Organic waste storage** | 3 | 3 | 1 | 9 |
| **Inorganic waste storage** | 3 | 3 | 1 | 9 |

**Analysis of Building Structure of TPS UIKA Plan**

Temporary Shelter (TPS) of Ibn Khaldun University Bogor is designed using reinforced concrete material and with a roof covering structure using a concrete slab structure. The specifications of the TPS UIKA Bogor structural material use concrete quality of 24.9 MPa, yield strength (fy) of 390 MPa (threaded) and 300 MPa (plain). The land area provided by the Ibn Khaldun University Bogor Campus is 234 m2 and the planned land area of TPS UIKA Bogor is 87.5 m2 (17.5 x 6 m). The available land area has met the requirements of SNI 19-2452-2002, which is 200 m2. The planned building area of TPS UIKA Bogor is 60 m2 (10 x 6 m) and the number of floors of the planned building is 1 floor with a height of 3.2 m. Analysis of the TPS UIKA Bogor structure by considering the loads acting on the TPS UIKA building structure such as dead load (the weight of building materials that are automatically entered into the ETABS V21.0.0 application), live load (rain load), and additional dead load (building components) using the ETABS V21.0.0 application. Details of additional dead loads and live loads on the planned building are presented in Table 6.

**Table 6.** Plan dead loads and live loads

| Loading data input | Load type | Result |
|---|---|---|
| SIDL dead load | Load on portal (concrete) | 108 kg/m$^2$ |
| | Ceiling + hanger | 22 kg/m$^2$ |
| | Electrical installation | 25 kg/m$^2$ |
| | Concrete roof | 288 kg/m$^2$ |
| | Total | 443 kg/m2 or 4.43 kN/m2 |
| Live load | Rain load | 1 kN/m2 |

**Results of Design Structure Modeling**

The results of the design building structure modeling using the ETABS V21.0.0 modeling application are stated to be quite safe against the influence of external forces with no structural elements experiencing structural failure as seen in Figure 7, then entering the manual calculation stage for beam and column element analysis to re-check and calculate the reinforcement requirements.

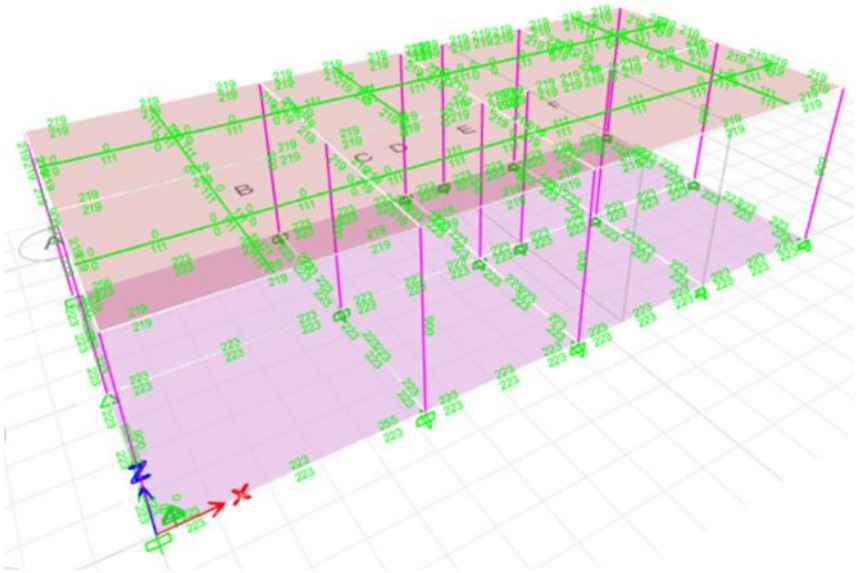


**Figure 7.** Results of the analysis of the structural modeling of the TPS building plan Source: Analysis results

**Calculation of design beam reinforcement**

Calculation of reinforcement requirements in design beam elements using the Ms Excel application by entering the output of the ETABS application to obtain the required moment (Mu) and the required load (Vu) and torsional load (Tu) to determine the flexural and shear reinforcement, structural modeling in the form of internal forces is shown in Table 7.

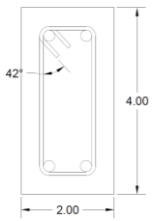
**Table 7.** Output force in the beam

| Beam | Mu (-) (kNm) | Mu (+) (kNm) | Vu base | Tu (kNm) |
|---|---|---|---|---|
| B20x40 cm | 7.449 | 9.928 | 8091.6 | 0.0017 |

Source: Analysis results

From the data, calculations are then carried out based on SNI 2847-2019 Article 9.5.1, namely Sn ≥ U, the planned beam reinforcement is shown in Table 8.

**Table 8.** Details of beam reinforcement design

| Beam Name | Beam Reinforcement | Reinforcement Details | | Picture |
|---|---|---|---|---|
| | | Support Shear Reinforcement | Field Shear Reinforcement | |
| B20 x 40 cm | 2D14 | Ø 10 - 50 | Ø 10 - 100 |  |



**Calculation of design beam reinforcement**

Calculation of column elements by checking the output of the ETABS application in the form of forces using the Ms Excel application to obtain the maximum load and moment is shown in Table 9.

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**Table 9**. Output columns in ETABS

| | | | Story 1 | |
|---|---|---|---|---|
| P | Max | = | -5.3509 | 5.3509 |
| | Min | = | -46.1869 | 46.1869 |
| V2 | Max | = | 6.5303 | 6.5303 |
| | Min | = | -0.6616 | 0.6616 |
| V3 | Max | = | 7.9376 | 7.9376 |
| | Min | = | -0.0991 | 0.0991 |
| M2 | Max | = | 13.4707 | 13.4707 |
| | Min | = | -9.7073 | 9.7073 |
| M3 | Max | = | 11.5186 | 11.5186 |
| | Min | = | -7.5499 | 7.5499 |

Based on Table 9, it is then entered into the SPColumn application to create a column interaction diagram as in Figure 8.

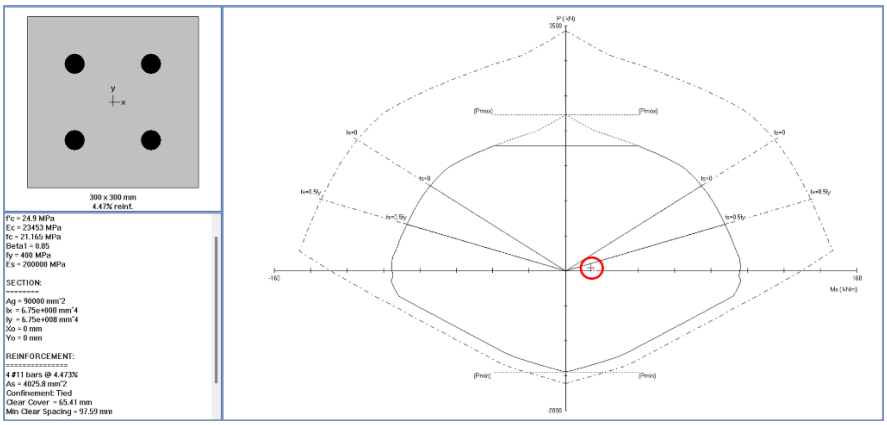
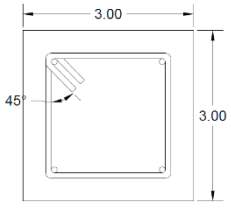



**Figure 8.** Column interaction diagram K30x30 cm

The results of the analysis of the K30x30 cm column using SPColumn are that the ratio value of the K30x30 cm column meets the requirements of 4.47% according to SNI 2847_2019 Article 10.6.1 and the Mn / Mu value> 1.0 which indicates that the column capacity is greater than the external load that works. It can be concluded that the K30x30 cm column is declared safe, the reinforcement recapitulation is shown in Table 10.

**Table 10**. Column reinforcement detail plan

| Column Name | Column Reinforcement | Stirrup Reinforcement | Picture |
|---|---|---|---|
| K30 x 30 cm | 4D14 | Ø 10 - 150 |  |

## CONCLUSION

The conclusion from this study is that the application of the green campus concept at the Ibn Khaldun University Campus in Bogor has met the criteria for a green campus based on the Ministry of Research, Technology and Higher Education with supporting factors, namely the provision of waste processing facilities in the form of TPS. Based on the results of the survey of waste generation and composition with calculations using Ms Excel, it is known that the amount of waste generated at the UIKA Bogor TPS is 26.12 m3/month. The results of the UIKA Bogor TPS building plan design are able to temporarily accommodate recyclable waste with a capacity of 9 m3, so that with a pile of 40.88% it can be accommodated for approximately 3 weeks. In order to realize this goal, it is necessary to carry out modeling and calculation of structural analysis of the planned building, in order to ensure that the structure is suitable for use or not. The UIKA Bogor TPS building is designed using reinforced concrete materials and with a roof covering structure using a concrete roof structure. The specifications of the UIKA Bogor TPS structural material use concrete quality of 24.9 MPa, the quality of the yielding steel reinforcement (fy) of 390 MPa (threaded) and 300 MPa (plain). The column dimensions are K30x30 cm (bearing area with 4D14 main reinforcement, ø10-150 mm shear reinforcement). The dimensions of the main beam are B20x40 cm (bearing area with 2D14 reinforcement, ø10-50 mm shear reinforcement and bearing area with 2D14 reinforcement, ø10-100 mm shear reinforcement). The thickness of the concrete roof slab is 12 cm (two-layer and two-way reinforcement with ø12-100 mm. The Temporary Shelter (TPS) of UIKA Bogor was analyzed using the ETABS V21.0.0 application. The output results of the analysis of the planned TPS UIKA Bogor building structure are purple on the column with a strength ratio of 0.90 to 0.95 and green on the beam with a ratio of 0.50 to 0.70 which indicates that the structure is quite safe against the working load.

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