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Assessment of the Durability of Steel and Concrete Structures of Construction Buildings in Construction (KDP) (Case Study of Still Buildings)

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ABSTRACT: Detailed structural planning of a multi-storey building requires a long and complicated series of analysis and calculation processes, which are based on certain technical assumptions and considerations

The aim of the activity is to inspect the condition of the structure of the stalled building in KDP status, both in terms of material quality and other structural properties such as dimensions, layout and number of reinforcements and the strength of the structure itself. After that, an overall structural analysis of the building is carried out to determine the structural dimensions that meet the requirements.

The results of this research, namely, based on the results of the inspection and analysis of existing conditions, state that, a building in construction under construction (KDP) status that has been abandoned for several years means the structure has experienced changes in strength so that it no longer corresponds to the initial calculations, both in terms of strength and cost.

Policy makers must be more careful in determining budgets so that they do not hinder the implementation of construction work which results in buildings being stalled. Which of course will affect a number of things which will certainly be detrimental to all parties, especially government buildings whose source of funds comes from paying public taxes.

KEYWORDS: stalled, structure, KDP

A. INTRODUCTION

Detailed structural planning of a multi-storey building requires a long and complicated series of analysis and calculation processes, which are based on certain technical assumptions and considerations. The sophistication of software available today allows technicians to plan everything from various points of view in great detail with a high level of accuracy.

It is important to realize that the reliability of the results of a calculation is very dependent on the quality of the input. Often planners follow all the output results of a computer without reviewing whether the output results contain any irregularities. Sometimes these irregularities are not easy to find because the planners do not have or lack sensitivity to the behavior of the planned structure.

The planning process begins with discussion and collaboration between disciplines, then the structural planner will create planning criteria (design criteria) for structures that are considered the most economical and can meet all the requirements of other disciplines. These planning criteria include, among others, design philosophy, type and magnitude of loading, strength and stability, stiffness and limitation of deformation, usability, creep, shrinkage, influence of temperature and resistance to fire as well as limitation of settlement and differences in settlement including soil-structure interaction.

The process of building a building is carried out starting from foundation work to installing detailed elements that make up the building itself.

In this article, we will discuss buildings in the KDP but which have been in a state of disrepair for years. The case study carried out was on a building that had been built with progress up to the construction of a concrete foundation structure with a column frame and steel beams and then abandoned in the open until now.

Abandoned structural parts will directly affect the strength of both the concrete and steel installed and left in the open, causing the concrete surface to experience cracking and reinforcement and steel to rust.

This can certainly result in the structure experiencing a decrease in its ability to carry loads or degradation in strength. So it is necessary to check the suitability of the existing structure for the working loads.

Based on the considerations above and considering the function of the building, it is necessary to examine the suitability of the existing building structure to withstand the working loads so that the condition of the existing building can be known and can be followed up.

In this activity, an examination of the condition of the existing structure is carried out both in terms of material quality and other structural properties such as dimensions, layout and number of reinforcements and the strength of the structure itself. After that, an overall structural analysis of the building is carried out to determine the structural dimensions that meet the requirements.

A stalled building is a building or other architectural structure such as a bridge, road, or tower whose construction stops midway or never starts. Stalled buildings also refer to buildings that are currently under construction, especially buildings whose construction is delayed or progressing very slowly.

B. LITERATURE REVIEW

1. Location

Merauke City is in the South Papua Province, geographically located at 1370 - 1410 East Longitude and 50 - 90 South Latitude. The area of Merauke city reaches 46,791.63. Merauke district city is located on the coast. Meanwhile, the water area in the city of Merauke and Merauke district as a whole reaches 5,089.71 km^2.

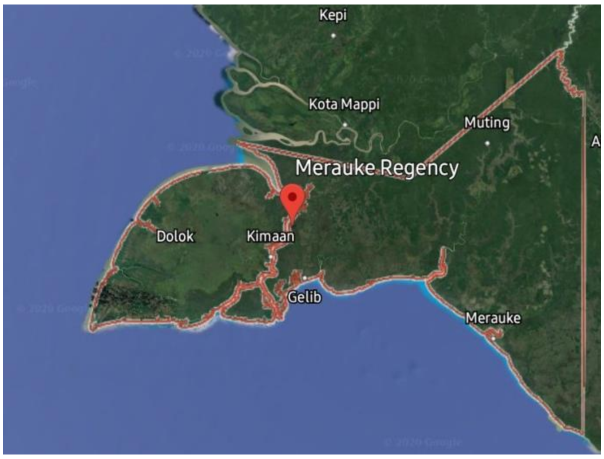

Figure 1. Map of research location

The research location is on Jalan Tawarakai, Muli sub-district, Merauke sub-district, Merauke city, South Papua province

2. Building during the KDP period

According to the Director General of Treasury Regulation Number PER38/PB/2006, KDP are assets that are in the process of being developed or whose acquisition process has not been completed at the end of the accounting period. PSAP 08 paragraph 6 also explains the definition of KDP, namely assets that are in the development process.

Construction in progress includes land, buildings and structures, equipment and machines, roads, irrigation and networks, as well as other fixed assets where the process of acquiring and/or completing work on a fixed asset exceeds and/or exceeds one fiscal year period, then unfinished fixed assets The asset is classified and reported as KDP until the asset is completed and ready for use.

3. Construction Stalled

Referring to Wikipedia, the definition of a stalled building is a building or other architectural structure such as a bridge, road or tower whose construction stops midway or never starts. Stalled buildings also refer to buildings that are currently under construction, especially buildings whose construction is delayed or progressing very slowly.

4. Climate

The climate conditions of the Merauke district city area based on BMKG data for Merauke district show variations between 25.60 Celsius to 28.40 Celsius. Meanwhile, air humidity will vary between 76 and 86 percent in 2022. Meanwhile, the intensity of solar radiation in 2022 will vary between 30.0 and 70.4 percent on average and the air pressure will be between 1008.1 and 1010.8 mb.

5. Structural Design Requirements

In the process of building construction work, it is necessary to pay attention to the structural requirements, as follows:

1. Stability Requirements: Static and Dynamic
2. Strength Requirements: Static and Dynamic
3. Ductility Requirements: Elastic (Fully Elastic). Limited ductility, full ductility
4. Conditions suitable for use in serviceability:
   a. Deflection of plates and beams
   b. Building drift (lateral drift)
   c. Interstory drift
   d. Acceleration, especially structural design against the influence of wind
   e. Cracks
   f. Vibration / vibration (vibration)
5. Durability requirements:
   a. Minimum compressive strength of concrete
   b. Concrete blanket thickness
   c. Type and cement content d. Corrosion review
   d. Steel quality
6. Requirements for fire resistance
   a. Minimum dimensions of structural elements/ components
   b. Concrete blanket thickness
   c. Thick protective layer for fire resistance
   d. Period of fire resistance (upper structure and basement)
7. Integrity requirements: Prevention of progressive collapse (usually with the addition of supporting reinforcement between precast concrete components)
8. Conditions related to construction implementation
   a. Adjustments to construction methods commonly carried out in the local area.

b. Building materials and the quality of the materials available.
c. Weather conditions during implementation
d. Availability of various local resources.
9. Applicable regulations and standards.

6. Review and Design Provisions

The design method uses conventional methods with reinforced concrete and conventional steel materials for the main building structure. Several aspects need to be reviewed which will influence the building design, including:

a. Structure planning regulations/guidelines
b. The concept of structural system selection
c. Building structural materials/materials
d. Structural loading concept
e. Structural component planning concept

Regulations / Guidelines for Structural Planning In designing the Musamus University Audiotorium building, the main structure uses conventional steel materials. The regulations/guidelines that will be used as a reference are:

a. Minimum Loads for Designing Buildings and Other Structures (SNI 1727 - 2020).
b. Procedures for Earthquake Resistance Planning for Building and Non-Building Structures (SNI 1726 - 2019).
c. Geotechnical design requirements (SNI 8460 – 2017). d. Procedures for Planning Steel Structures for Buildings (SNI 1729 - 2020).

7. Structure Selection Concept

The choice of upper structure type has a close relationship with the building's functional system. In the structural design process, it is necessary to look for the closeness between the type of structure and problems such as architectural, efficiency, serviceability, ease of implementation and also the costs required. Several aspects determine the choice of structural system, namely:

a. Architectural aspect: This relates to the plan and shape of the structure chosen, viewed from an architectural perspective.
b. Functional aspect, related to the use of space, which will usually influence the span of the structural elements used.
c. Aspects of structural strength and stability. This includes the structure's ability to accept applied loads, both vertical loads and lateral loads caused by earthquakes as well as structural stability in both conditions.
d. Economic aspects and ease of implementation. Economic factors and ease of carrying out work are factors that influence the structural system to be chosen.
e. The building's ability factor in accommodating the building service system. The choice of structural system must also consider the structure's ability to accommodate the existing service system, namely regarding mechanical and electrical work.

The structural system used to resist seismic forces is a Special Moment Resisting Steel Frame System with Concentric Bracing.

8. Quality of Materials/Building Structural Materials

a. Reinforced Concreate

Concrete is a structural material that has good compressive capacity, but weak tensile capacity. Concrete material has advantages compared to steel material, namely that it is heat resistant. Reinforced concrete is used for foundations, pile caps, sloofs, columns, beams, floor plates, roof plates, stairs and ramps.

1. Mechanical properties of Reinforced Concrete:
a. Density: 240 kg/m3
b. Specific gravity (BJ): 2400 kg/m3
c. Poisson number (μ): 0.2
d. Coefficient of thermal expansion (α): 9.9 × 10-6cm/°c
e. Shear modulus (G): 97,708.33 kg/cm2
2. Specifications for the concrete materials used are as follows:
a. Pile Foundation: K – 450 kg/cm2
b. Drilled Pile Foundation: K – 300 kg/cm2
c. Pile caps, Sloofs, & Ladders: K – 300 kg/cm2
d. Concrete work floor B0 : K – 100 kg/cm2
e. Columns, Beams & Basement Floor Plates - Roof: K – 300 kg/cm2
f. Basement Walls: K – 300 kg/cm2
g. Equipment foundation M/E: K – 300 kg/cm2
3. Concrete Modulus of Elasticity

Table 1. Modulus of elasticity of concrete

Concrete Quality		Modulus Of Elasticity
K	Fc'	
(kg/cm^2)	(MPa)	(MPa)
450	37,35	28.723,89
300	24,9	23.452,95
100	8,3	13.540,57

b. Profile Steel

Profile steel is used in roof truss structures with the type of steel used being BJ 37. The profile steel used is in accordance with the provisions of the Procedure for Designing Steel Structures for Buildings Article 5.1.3 determines the mechanical properties of Steel for Buildings (SNI 1729 – 2020)

a. Minimum Breaking Stress (fu) = 370 Mpa
b. Minimum Yield Stress (fy) = 240 Mpa
c. Minimum stretch (ε) = 20 %
d. Modulus of Elasticity (E) = 200,000 Mpa
e. Shear Modulus (G) = 80,000 Mpa
f. Poison ratio (μ) = 0.3
g. Expansion Coefficient (α) = 12*10^6 /ºC
h. Welding wire quality = AWS – E70 XX.
i. Quality of connection bolts = HTB A – 325
j. Quality of anchor bolts = ASTM A – 307

Table 2. Mechanical Properties Of Structural Steel

Steel Type	Minimum Breaking Stress, f_u (MPa)	Minimum Breaking Stress, f_y (MPa)	Minimum Stretch (%)
BJ 34	340	210	22
BJ 37	370	240	20
BJ 41	410	250	18
BJ 50	500	290	16
BJ 55	550	410	13

9. Concepts Of Structural Loading

Load is a force or other action that is obtained from the weight of all building materials, occupants, items inside the building, environmental effects, differences in displacement, and restraining forces due to changes in dimensions. Building structures must be able to accept various kinds of loading conditions that may occur. Errors in load analysis are one of the main factors in structural failure. Therefore, before carrying out structural analysis and design, it is necessary to have a clear picture of the behavior and magnitude of the loads acting on the structure and their characteristics.

The loads used in the design of buildings and other structures must be the maximum loads expected to occur due to occupancy and use of the building, but must not be less than the minimum uniform load specified in the Minimum Loads for the Design of Buildings and Other Structures (SNI 1727 - 2020) . Meanwhile, earthquake loads must comply with the Earthquake Resistance Planning Procedures for Building and Non-Building Structures (SNI 1726 - 2019).

Once the loads acting on the structural elements are known, in designing the structural elements it is necessary to take into account the possibility of a combination of loads from several load cases that can act simultaneously during the design life. The load values mentioned above are multiplied by a magnification factor called the load factor, the aim being that the structure and its components meet the strength requirements and are fit for use against various load combinations. Load combination configuration based on SNI 1726 - 2019, load combinations are also used to obtain the maximum load that may occur when loads work individually or simultaneously

a. Combination of Factored Loads and Service Loads

Structural components must be designed so that their design strength is equal to or exceeds the influence of factored loads with load combinations in accordance with article 4.2 of SNI 1726 - 2019 for the ultimate method as follows:

1. 1,4 D
2. 1,2 D + 1,6 L + 0,5 (Lr or R)
3. 1,2 D + 1,6 (Lr or R) + (L or 0,5W)
4. 1,2 D + 1,0 W + L + 0,5 (Lr or R)
5. 0,9 D + 1,0W

b. Loading Combinations Effect of Earthquake Loads If a structure is affected by seismic loads, then the following load combinations must be taken into account together with the basic load combinations above. The most important influence of seismic loads must be considered, but does not need to be taken into account simultaneously with wind loads. If the influence of the seismic load in question, E = f (Ev, Eh) in article 7.4.2 SNI 1726 – 2019 and article 8.3.1 SNI 1726 – 2019, is combined with the influence of other loads, then the seismic combination that must be used is:

1,2 D + Ev + Eh + L

0,9 D - Ev + Eh

If the influence of seismic loads with greater strength is considered, Em = f (Ev, Emh) in article 7.4.3 SNI 1726 – 2019 and article 8.3.2 SNI 1726 – 2019, combined with the influence of other loads, then the seismic combination that must be used is :

1,2 D + Ev + Emh + L

0,9 D - Ev + Emh

C. METHOD

a. Case Limitations

This research limits the discussion to cases of buildings that are stalled or whose construction has been delayed for more than 2 years and under 8 years after construction.

b. Materials and tools

The tools that will be used to make observations at the research location include measuring instruments such as: theodolite, meter, camera and test hammer.

c. Implementation Stages

1. Work plan

The Work Plan relates to the scheduling of each activity according to the sequence and time of implementation. The division/allocation of time is adjusted to the predetermined time allocation.

2. Visual inspection of the physical condition of the structure

Observe each structural element visually to determine physical damage due to the condition of the building which can affect the strength of the concrete structure and reinforcement that has been installed and steel that has not been installed.

3. Material measurement and testing

Measure dimensions of existing structural components consisting of steel beams and columns, structure layout. Material testing is carried out to determine the quality of existing concrete using the Hammer Test method. These data can then be used as a reference.

4. Structure Technical Study Report

The structural technical study report contains the results of topgraphic measurement observations and concrete testing in the field.

D. RESULT AND DISCUSSION

1. Result

a. Structural Analysis

Information data according to the RKS design reference is:

a.1. Concrete quality requirements

Structural Concrete Requirements for Foundations, Sloofs and Pedestal Columns: K225 Kg/cm².

a.2. Steel Structure Regulations

Specifications for Structural Steel Buildings SNI1729:2015 AISC-LRFD Specification for Structural Steel Buildings 2005 AWS Structural Welding Code 1996

b. Material Quality Analysis

b.1. Steel:

a) HB 400 b) HB 300 c) WF 700 d) WF 600 e) WF 500 f) WF 400

b.2. Concrete

Quality Concrete K 225 kg/cm² or equivalent to f'c 18.68 Mpa.

Data from the hammer test results are assumed to have quality with the following average values:

a) Pedestal Column Concrete K258.81 kg/cm² or equivalent to f'c 21.48 Mpa
b) Sloof Concrete K279 kg/cm² or equivalent to f'c 23.17 Mpa
c) Floor Plate Concrete K257.22 kg/cm² or equivalent to f'c 21.35 Mpa

Pedestal Column:

a) SNI Plain Steel Main Reinforcement: 8 (Ø) 16 mm
b) SNI Plain Steel Stirrup Reinforcement: (Ø) 8 – 150 cm

Sloof:

a) SNI Plain Steel Main Reinforcement: 12 (Ø) 16 mm
b) SNI Plain Steel Stirrup Reinforcement: (Ø) 10 – 150 mm

Platform:

a) Wiremesh Reinforcement Main Reinforcement Plain Steel SNI: (Ø) 10 – 150 mm

c. Material Measurement and Testing

c.1. Existing condition of steel structures

Observations were carried out directly at the case study research location of buildings that had been idle for more than 5 years.

From the results of measurement and identification, the following conditions are produced:

1. The steel column is not placed correctly on the pedestal column (not symmetrical)
2. The steel material peels off a lot until the flesh of the steel reduces its thickness.
3. Many anchor bolts and connecting bolts between structures are missing and rusty.
4. Some columns have not been installed on the pedestal so the anchor bolts are rusty and prone to corrosion.

From observations of steel structures in the field, results were obtained as shown in the image below.

Figure 2. **Column placement on the pedestal**

Figure 3. The condition of the columns and beams is rusty and peeling

Figure 4. The condition of the bolt and weld connections is rusty

Figure 5. Condition of the floor plate and pedestal column anchors

c.2. Geometry Measurements

Geometric measurements are carried out to determine the span distance of the structure (distance between columns), the distance between floors and the dimensions of structural elements, namely beams, columns and floor plates.

Measurements are carried out using a meter measuring instrument. Measuring structural elements of beams and columns can be done directly, while plate thickness is done by finding the difference between the total height of the beam and the height of the beam below the plate.

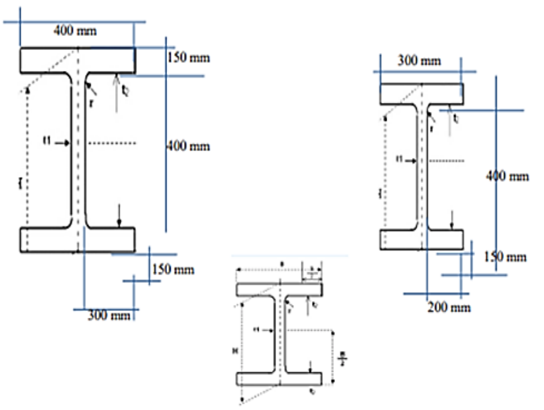

Figure 6. Steel structure measurement results

Figure 7. Measurement of steel columns and beams

c.3. Reinforcement Measurement

Measurement and identification of the reinforcement installed in the structural elements of pedestal beams and columns is carried out by peeling/breaking the concrete cover. Stripping is carried out until the number of reinforcement and spacing of shear reinforcement can be seen. Measuring the diameter of reinforcement with calipers.

Figure 8. Concrete breaking process

Figure 9. Measurement of reinforcement distance

Figure 10. Measuring bone diameter with a caliper tool

Figure 11. Measuring bone diameter with a sigmat tool

Figure 12. Measurement of beugel height

From the results of the reinforcement measurements, it was found that the Pedestal column reinforcement consisted of plain (SNI iron) (main) and plain (sengakang) reinforcement, while in the Sloof, plain reinforcement was attached to both the main reinforcement and stirrups. Based on the overall measurement results, the dimensions of the structural elements of steel beams and columns, pedestal columns and floor plates, as well as the number and size of the reinforcement, are obtained. The results of these measurements are used as a reference in making structural drawings as follows:

Table 2. Existing Column and Sloof Size Dimensions

No.	Description	Dimensions	Distance of main reinforcement	Stirrup reinforcement spacing	concrete blanket table
1	Pedestal Column	130 x 130 cm	8 Dia 16 mm	Dia 8 – 15	30 – 40 mm
2	Sloof	40x 80 cm	10 Dia 16 mm	Dia 10 – 150 mm	30 – 40 mm
		20 x 40 cm	10 Dia 16 mm	Dia 10 – 150 mm	30 - 40 mm
		40 x 60 cm	12 Dia 16 mm	Dia 10 – 150 mm	30 – 40 mm
		50 x 90 cm	12 Dia 16 mm	Dia 10 – 150 mm	30 – 40 mm

c.4. Concrete Testing

Concrete compressive strength testing is carried out using a Hammer test tool by taking certain points spread across columns, beams and plates. This is intended to obtain a distribution of concrete quality according to existing conditions. The following is the Hammer test data collection.

Figure 13. Pedestal column concrete hardness testing process

Figure 14. Process of testing sloof concrete hardness using a hammer test

Figure 15. Process of testing floor plate concrete hardness using hammer test

2. DISCUSSION

Hammer test data is used as a reference to determine concrete quality and to determine the distribution of concrete quality uniformity. However, the data from the hammer test results cannot be used directly in analysis.

Based on experience and references, the quality of concrete from the hammer test results used is in the range of 40% to 70%. The following are sample points of Hammer test data on existing structural elements. The hammer test data is then processed at the Civil Engineering Laboratory at Musamus University.

The results of data processing are the concrete quality of the combined characteristics of slabs, beams and Pedestal columns, namely K-369.73 kg/cm^2, for Sloof concrete, for pedestal columns the concrete quality reaches K - 398.79 kg/cm^2, and for floor plate concrete The concrete quality is K – 367.45 kg/cm^2, however, in the analysis the average concrete quality value is only taken as 70% of the characteristic concrete quality resulting from the hammer test. This is because concrete in the open will experience hardening on surfaces that have been overgrown with wild plants and based on several test results and hammer test references, the results obtained are still greater than the actual conditions. Apart from that, looking at the distribution of hammer test results which are almost uniform for each concrete tested, so that in the analysis only around 70% is taken, so the quality of the concrete used is K-279 kg/cm2 or the equivalent of f'c 23.17 MPa, for concrete Sloof, and for concrete pedestal columns it is K- 258.81 kg/cm² or equivalent to f'c 21.48 MPa, and for concrete floor plates it is K – 257.22 kg/cm² or equivalent to f'c 21.35 MPa , (test results data can be seen in the Hammer Test Results attachment).

E. CONCLUSION

The results of visual observations show that the condition of the structure only experienced minor damage, but in several structural elements such as steel, there was rusting and peeling of the steel material itself on the installed steel columns and beams, resulting in a decrease in the quality and strength of the steel.

From the results of field observations, namely measuring dimensions and checking reinforcement, we obtained the dimensions of the existing beam and column structures and their reinforcement which are depicted in the schematic drawing in the attachment, and the calculation results of the volume of steel installed were 120 tonnes (21%), not yet installed was 105 tonnes.

The required quality of concrete is K 225 quality concrete or the equivalent of 18.68 MPa. The results of statistical analysis of the hammer test results that have been carried out show the characteristic compressive strength values ranging from concrete quality as follows K-398.75 kg/cm^2, for Sloof concrete, for pedestal columns the concrete quality reaches K – 369.73 kg/cm^2, and for floor slab concrete the concrete quality is K – 367.45 kg/cm^2, but 70% is taken so that the quality of concrete used is K-279 kg/cm^2 or equivalent f'c 23.17 MPa, for Sloof concrete, and for pedestal column concrete it is K- 258.81 kg/cm² or equivalent f'c 21.48 MPa, and for floor slab concrete it is K – 257.22 kg /cm² or equivalent to f'c 21.35 MPa.

REFERENCES

1. Regulation of the Minister of Public Works and Public Housing Number 3 of 2020 concerning Amendments to Regulation of the Minister of Public Works and Public Housing Number 27/PRT/M/2018 concerning Certificates of Building Functionality;
2. SNI 03-1734-1989 Procedures for planning concrete and reinforced wall structures for houses and buildings
3. SNI 03-2847-1992 Procedures for calculating concrete structures for buildings
4. SNI 03-1727-1989 Procedures for planning loads for houses and buildings
5. SNI 03-1726-2002 Procedures for earthquake resistance planning for houses and buildings
6. SNI 2847-2019 Requirements for Structural Concrete for Buildings SNI 1726-2019 Requirements for Structural Concrete for Buildings
7. SNI 1729-2020 Specifications for Structural Steel Buildings
8. SNI 03-1729-2002 Procedures for planning steel structures for buildings
9. Law Number 28 of 2002 concerning Buildings