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1 STRUCTURAL DESIGN OF THE SOUTH KALIMANTAN PROVINCIAL HEALTH LABORATORY BUILDING, PHASE II, USING STEEL STRUCTURE BASED ON SNI 1729-2020

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ABSTRACT

To overcome the low soil carrying capacity I the Banjarmasin city, in addition to planning a good foundation, it is also necessary to choose lighter materials, one of which is steel material. As the topic of the study, *Phase II of the Design of the* South Kalimantan Provincial Health Laboratory Building uses a steel structure, a simulation will also be carried out by increasing the number of floors to then re-examine the capacity of the existing understructure. The design results for secondary beams and *primary beams* use WF 346x174x6x9 and WF 400x200x8x13, columns use H profile 350x350x12x19. Rigid Connection is carried out on the connection of moment-resisting beams and Simple Connection on the secondary beam-primary beam. The capacity of the existing substructure after planning the building structure with steel structures indicates that the existing substructure can still carry the maximum load if one floor is added.

Keywords: LRFD, OMF, Steel Structure, Rigid Connection, Simple Connection, Earthquake, Pile Foundation, Pile Cap

1. INTRODUCTION

Banjarmasin City is an area whose land condition is swampy so it has a low soil strength capacity. This type of soil with soft characteristics has the potential to damage buildings, especially due to earthquakes, to overcome the problem of the carrying capacity of the soil. In addition to good foundation planning, it is also necessary to be supported by the use of lighter building materials, one of which is steel material. Steel is a material that has high strength but is lightweight. For this reason, as a study material, the Design of the South Kalimantan Provincial Health Laboratory Building Phase II, which previously used conventional concrete structure materials, was planned to return to using steel structures based on SNI-1729-2020.

The design of the upper structure includes primary and secondary structures after which the planned structure will be evaluated for the performance of the existing lower structure with variations in the number of floors, the reason for the selection of the South Kalimantan Provincial Health Laboratory Building Phase II because it is a low-rise building that has a stage structure that is characteristic of buildings in the Banjarmasin area so that it is often found in the Banjarmasin city community, so the author hopes that the results of this Final Project can be used as a reference in planning steel structures by the general public, especially the people of Banjarmasin city.

2. THEORETICAL STUDY

Characteristics of Steel Material

The mechanical properties of steel including the melting voltage and break voltage used in the planning must meet the minimum requirements given in table 1. Other material properties of structural steel for designing purposes are established as follows:

Poisson ratio: $\mu = 0.3$ Coefficient Expansion: $\alpha = 1.2 \times 10\text{-}5$

Modulus young: E = 200,000 MPa Shear modulus: G = 72000 MPa

Table 1 Mechanical properties of structural steels

Types	Yield limit F_y (MPa)	Ult strength F_u (MPa)	Min Stretch (%)
BJ 34	210	340	22

BJ 37	240	270	20
BJ 41	250	410	18
BJ 50	290	500	16
BJ 55	410	550	13

(Yudha Lesmana,2008)

Structural System

The truss system that will be used in the planning of steel structures this time is the moment frame system, this system is a space dimensional frame system where the beam, column and, join structures withstand the forces acting through bending, shear and, axial actions. The frame must meet the strong column-weak beam so that plastic joints do not occur in the column that can cause soft stories.

Design of Structural Elements

In planning a steel structure, there are parts/elements, each of which has its function and capacity calculation according to the criteria and loads that work on a steel profile.

Tensile strength of steel

Based on SNI 1729-2020, chapter D2. Strength tensile design *ØPn* is the lowest value obtained according to the state of the yield limit of tensile at the gross cross-section and pull collapse at the net cross-section of melt collapse.

1. For melt pull at the gross cross-section

   $Pn = Fy\,.Ag$ 1)

   Øt = 0.9
2. For the collapse of the attraction on the net cross-section;

   $Pn = Fu.Ae$ (2)

   Øt = 0.75

Compressive Strength Steel

Based on SNI 1729-2020, chapter E1. The nominal compression strength of *Pn* should be the lowest value obtained based on the boundary state of bending, torsional bending, and torque-bending bending.

$Pn = FcrAg$ (3)

The critical voltage, Fcr, is determined as follows:

$then\ caphe\ \frac{KL}{r} \leq 4{,}71.\sqrt{E/Fy}$ or Bend inelastically, then$\frac{Fy}{Fe} \leq 2{,}25,$ (4)

$F_{cr} = \left(0{,}658^{\frac{F_y}{Fe}}\right).F_y$

1) $\frac{KL}{r} > 4{,}71\sqrt{E/Fy}$ or , bend elastically, then $\frac{Fy}{Fe} > 2{,}25$ (5)

$F_{cr} = 0{,}877.Fe$

Bondek Plate Planning

Bondek Floor Slab calculations are used as a one-way positive reinforcement as already listed on the *Union Floor Deck W-1000* brochure. For the calculation analysis of the floor deck slabs, use the formula from the *Steel Deck Institute* 2011.

Foundation

Foundation is a construction at the base of the structure (sub-structure) which has the function of passing the load from the top of the structure (upper structure) to the supporting soil layer below without causing soil shear collapse and excessive soil or foundation subsidence.

3. METHOD

Design Data

Project Data:

Project name: Construction of Health Labroratorium Building South Kalimantan Province Phase II

Project Location: Jl. Bumi Mas Raya, Pemurus Baru, South Banjarmasin

Building function: Health Laboratory Building

Number of stories: 5 stories

existing structure of the building: Reinforced concrete construction

Figure 1 Location Map of the South Kalimantan Provincial Health Laboratory Building Construction Project Phase II

(Source: Google Earth 2022)

Predesign procedure

1) Preparatory stage, that is, collecting all the necessary data,
2) *Preliminary Design*, which is the stage in carrying out an estimate of the initial dimensions of the elements of the structure,
3) Calculation of loading,
4) Planning of secondary structures,
5) Creation of 3D modeling of structures with ETABS applications,
6) Control of modeling of the structure,
7) Calculation of the connection based on the applicable specifications,
8) Addition of the number of floors on modeling,
9) The calculation of the capacity of the existing foundation is based on the results of the *Cone Penetration Test* (CPT) test and data on the results of the loading test in the field.

4. RESULTS AND DISCUSSION

Secondary Structure Design

In this Final Project, the secondary type structure to be planned includes planning the structure of stairs, floor plates, and beams. After analyzing the structure and calculations, the following results were obtained:

1) Stair Structure:

The planning of the stair structure with steel obtained the calculation results are used Stepping plates with a thickness of 3.5 mm with a support profile plate L 60 x 60 x 6, for bordes used a plate 8 mm thick with profile beam I 100 x 100 x 6 x 8, while the primary beams of the ladder uses a profile of WF 200 x 100 x 5.5 x 8 and the ladder stacking beam uses a profile I 200 x 200 x 8 x 12.

2) Floor slabs:

Floor slabs use floordeck from Union Floor Deck 0.7 mm thick with concrete slabs 120 mm thick for floor slabs and 110 mm for deck plates, for negative moment reinforcement installed wiremesh M10 – 200 for floor plates and wiremesh M8 – 200 for deck plates.

3) Secondary Beam

Planning of secondary beams with a composite beams method where the secondary beams use WF 346x174x6x9 profiles.

Primary Structure Design

Primary structure design includes the designing of the primary beams and the main column. In the process of analyzing the structure to get the inner forces will use the Etabs software as shown in figure 2.

1) Structural modeling:

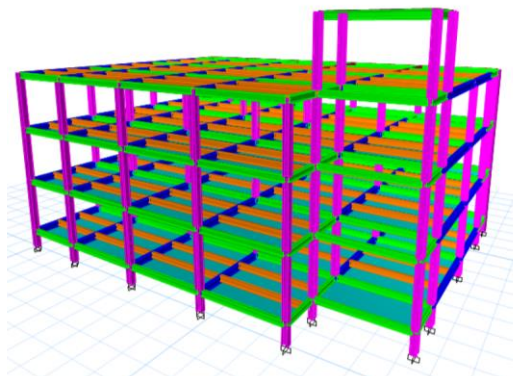

Figure 1 Structure modeling with Etabs

2) Structure Modeling Control

Before the inner forces can be used, the modeling of the structure needs to be checked again by the limitations of the stability of the structure by applicable standards, in this case after the calculation of the structure has been carried out to meet the requirements.

3) Primary Beams and Main Column Planning

Planning of the primary beams with composite beams where there is a main beam is used WF profile 400x200x8x13 in the longitudinal direction of the building. And WF 350 x175x7x11 profiles in the transverse direction of the building.

4) Connection Planning

End plate type *Rigid* Connection bolt joints are used in the connection of moment-retaining columns in both the direction of the weak axis and the strong axis of the column while the *Simple Connection* is carried out at the connection of the secondary beams-primary beams and the connection of the ladder structure. For the connection of *the base plate* used plates with a thickness of 20 mm and installed 4 pieces of stake.

The Capacity of The Existing Lower Structure

The determination of the capacity of the lower structure will be carried out based on the results of soil investigations in the field, this needs to be done to find out the type and characteristics of the soil in the place to be reviewed.

Carrying capacity of existing piles:

The calculation of the axial carrying capacity of the mast group can be seen in table 2.

Table 2 Axial capacities of existing pole groups

Pile Cap configuration	***Eff***	***Q allow (ton)***	***Q ag (ton)***	**Pu(ton)**	**Status**
2 pcs	0.896	50.67	90.80	39.93	*OK*
3 pcs	0.792	50.67	120.39	68.09	*OK*
4 pcs	0.792	50.67	160.52	124.49	*OK*
5 pcs	0.723	50.67	183.27	124.33	*OK*

After calculating the pile capacity for axial, lateral, and settlement, the results were obtained that the pile foundation could still carry the load of the steel building structure on it.

Increased Number of The Floors

In this section, an experiment will be carried out to increase the number of floors in the previously modeled structure. The increase in the number of floors will be carried out gradually per floor until the lower structure is no longer able to carry the load due to the increase in the number of floors. An additional floor will be inserted above the first floor, as for the floor plan, it is assumed to be typical of the second floor so that the working loads are also the same.

Structural modeling:

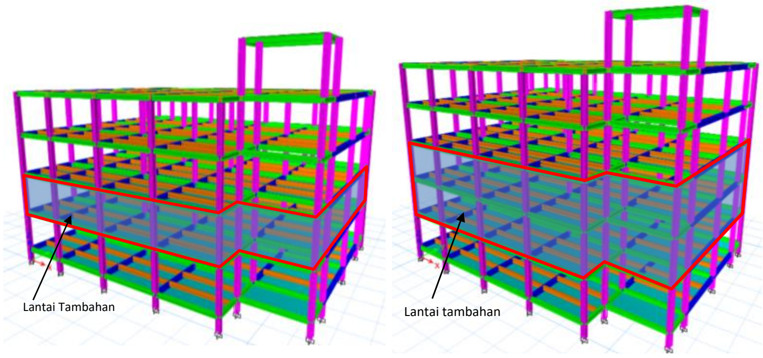

Figure 2 Modeling the structure of floor additions with Etabs

After an examination of the carrying capacity of the existing pile group in the experiment of adding two floors with a combination of gravitational load loading, the piles at the foundation point with a configuration of 4 pieces and 5 pieces were unable to carry the working load as shown in table 3, thus it can be seen that the addition of the maximum number of floors in the design modeling The structure of the South Kalimantan Provincial Health Laboratory Building Phase II uses a steel structure based on SNI 1729-2020 for the existing foundation is one floor.

Table 3 Capacity of existing pole groups for a two-story addition

Mast configuration	***Eff***	***Q allow (ton)***	***Q ag (ton)***	**Pu(ton)**	**Status**
2 pcs	0.896	50.67	90.80	61.97	*OK*
3 pcs	0.792	50.67	120.39	104.52	*OK*
4 pcs	0.792	50.67	160.52	189.40	*NOT OK*
5 pcs	0.723	50.67	183.27	187.36	*NOT OK*

5. CONCLUSION

The conclusions obtained in the Design Structural Design Of The South Kalimantan Provincial Health Laboratory Building, Phase II, Using Steel Structure are as follows.

1. Planning using a steel structure obtains the results of the primary beam using a WF profile of 400 x 200 x 8 x 13 in the longitudinal direction of the building, and a WF of 350 x 1 x 175 x7x11 in the transverse direction of the building, as well as the main column used profile H 350 x350 x1 2x19. As for the connection, it uses a bolted connection.

2. From the results of the analysis, it was found that the lower structure was able to steel structure with the addition of one floor compared to the existing building structure.

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