STUDY OF 7 BUILDING DEVELOPMENT PLANNING SPECIFICATION OF STEEL FRAMEWORK STRUCTURE (BASED ON SNI 1729 - 2015) (CASE STUDY: OFFICE BUILDING CONSTRUCTION PROJECT)

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ABSTRACT

Steel is a material that is widely used in industrial development and buildings with functions as the main building frame. This plan aims to plan a building structure with 7 floors plus a ground floor that will function as an office building with analysis using a Structure Analysis Program (SAP 2000 v.19) combined with steel regulations on SNI 1729: 2015. Based on the results of SAP analysis 2000 v.19 produces a column structure using WF Steel 400x400x30x50 with the beam 1 using the profile of Steel WF 350x300x14x23 and for the beam 2 using the profile of Steel WF 200x200x9x14. For anchor and baseplate using anchor M-25 with a length of 400 mm, with baseplate thickness of 25 mm and for bolts using M-25 bolts with a total of 16 bolts.

Keywords: Building Planning, Steel Frame Building, SAP 2000 v.19.

INTRODUCTION

Steel is a structure that is often used in multi-story buildings. Structural planning can be defined as a mixture of art and science combined with an expert structure institution regarding structural behavior with the basis of knowledge in statics, dynamics, material mechanics and structural analysis.

This plan uses the SNI 1729: 2015 regulations which are used in the calculation of current steel structures. In this plan using SAP 2000 v.19 modeling analysis combined with SNI 1729: 2015 regulations. This plan is used to analyze the capacity of the column structure, structure, and analysis on connection and anchor referring to the regulations concerning the applicable SNI.

This study aims to analyze the construction of office buildings using a steel frame structure that uses SNI 1729: 2015, to determine the strength of column and beam structures and to determine the needs of column and beam structures. The location of this study is at Bukit Golf Citraland, Surabaya City.

Review of Research Previously

The steel structure is the type of steel based on economic considerations, its strength, suitable for load bearers (PADOSBAJOYO, 1994). Steel structures are widely used for multi-story columns and beams, roof support systems, hangars, bridges, antenna towers, and others. During the period of introduction of steel as a building material until 1960, the steel used was carbon steel as the ASTM (American Society for Testing and Materials). Currently, there are many steel profiles that allow planners to increase the strength of the material in

the area of stress, so there is no need to increase the size of the stem dimension. Planners can decide based on the maximum rigidity or the lightest weight.

Structural planning according to Steel Building Building Specifications (SNI 1729: 2015) has a goal of producing a structure that is stable, strong, durable, and fulfills other objectives such as the economy and ease of implementation. A building is said to be stable if it is not easily rolled, tilted, or displaced during the age of the building plan. The risk of structural failure and loss of ability over the life of the plan can be minimized within acceptable limits. According to the journal from Budiman and HeriKhoeri with the title "Comparative Study of Steel Structures using WF Profile on HSS Profiles in Structure Columns" with conclusions where construction of construction is closely related to a structure that supports the construction. And the results of the study show that profiles using the HSS (Hollow Structural Section) profile column have a greater deviation, a greater stress ratio and a lighter weight of steel construction compared to the WF (Wide Flange) profile.

Basic Theory Used Imposition

Loading and combination of structural planning in building construction must take into account loadings such as dead loads, live loads, earthquake loads, wind loads, rain loads, and a structure must meet the strength of the plan by using a combination of SNI 1727: 2013 as follows:

- 1) 1.4D
- 2) 1.2D + 1.6L + 0.5 (La or H)
- 3) 1.2D + 1.6 (La or H) + (γ L. L or 0.8W)
- 4) 1.2D + 1.3 W + γ L. L + 0.5 (La or H)
- 5) 1.2D $\pm$ 1.0E + γ L. L
- 6) 0.9 D + (1.3 W or 1.0E)

According to the Earthquake Resilience Planning Procedure for Building Structure and Non-Building (SNI 1726:2012) the effect of the earthquake plan that must be reviewed in the planning and evaluation of building structures and non- building as well as various parts and equipment in general. In determining a class of sites classified according to the properties of the soil on the site, which includes the class sites SA, SB, SC, SE, or SF based on the results of data on the land investigation.

Figure 1. Spectrum Image of Surabaya City Design Response.

Structural Analysis

1. Beam Design

Loading on the beam is adjusted to the Indonesian Building Regulation (PPIUG) Regulation 1983, while the use of profiles is calculated based on SNI 1729: 2015.

a. The Examination of the cross section is found in SNI 1729: 2015 :

$$\frac{bf}{2xtf} \leq \lambda < 0,38 \sqrt{\frac{Es}{fy}}$$

$$\frac{d}{tw} \leq \lambda < 2,45 \sqrt{\frac{Es}{fy}}$$

- b. Examination Effect of lateral buckling and flexural strength

$$L_{bmax} = 0,086 \times iy \times \sqrt{\frac{Es}{fy}}$$

$$L_p = 1,76 \times iy \times \sqrt{\frac{Es}{fy}}$$

- c. Check the beam shear strength

$$\text{Shear Ratio} = \frac{Vu}{\phi_s \times V_n}$$

- d. Examination of slime and Shear Interactions

$$\frac{Mu}{\phi_b \times M_n} + 0,625 \times \frac{Vu}{\phi_s \times V_n} < 1,375$$

2. Coloumn Design

- a. The Examination of the cross section

For Wings :

$$\frac{bf}{2 \times tf} \leq \lambda = 0,38 \sqrt{\frac{Es}{fy}}$$

For Body :

$$\frac{d}{tw} \leq \lambda = 2,45 \sqrt{\frac{Es}{fy}} (1 - 0,93 \times Ca)$$

- b. Field check of slider column

$$L_{bmax} = 0,086 \times iy \times \sqrt{\frac{Es}{fy}}$$

- c. Field axial capacity check

- Determining the effective length of the column by using the Direct Analysis Method (DAM) :

$$\lambda_x = \frac{kx + Lb}{ix}$$

$$\lambda_y = \frac{ky + Lb}{iy}$$

- Check the tension of the elastic buckling

$$F_{ey} = \frac{\pi^2 \times Es}{\lambda_y^2}$$

METHODOLOGY

This steel portal structure has 7 levels in addition to the presence of a ground floor and rooftop that uses no roof with a height between 4m floors and varying distances between columns. The data obtained is then processed and analyzed. The stages of office building planning are like the flow chart in the picture below :

Figure 2. Research Methods

RESULTS AND DISCUSSION

In planning a 7story office building plus 1 ground floor, the structure is planned and designed using the SAP 2000 v.19 program then an analysis of the working structure is carried out.

Preliminary Design

Based on preliminary data and planning analysis at the beginning, the steel structure will be used as follows:

Table 1. Structure Plan Table

1	Beam 1	WF 250 x 175 x 7 x 11
2	Beam 2	WF 200 x 125 x 6 x 9
3	Column	WF 400 x 300 x 10 x 16

Spectrum Response

Calculation of seismic load and spectrum response analysis in this office building construction project uses an excel program and is combined with spectra design applications on the website www.puskim.pu.go.id. The results of these data are the classification of soil types of **soil rock sites (SB)**. in determining the spectrum response of the earthquake on the ground we use a seismic period of 0.2 seconds and 1 second, which results in:

$$S_{ms} = 0.662$$

$$S_{m1} = 0.248$$

$$S_{ds} = 0.44$$

$$S_{d1} = 0.164$$

from the above data we get the spectrum response graph image:

Figure 3. Figure Spectrum Response Graph

With values:

Response Modification Coefficient (R) = 8,

Strong factor - more system (Cd) = 3,

Deflection enlargement factor (Ω_0) = 5.5.

SAP Analysis and Structure

The results of structural analysis using Structure Analysis Program (SAP 2000 v.19) then obtained the profile and calculation of connections as in the table below:

Table 2. SAP Analysis Results Table :

No	Profile	Control	Results	Description
1	WFBeam 1 350 x 300 x 14 x 23	1. Cross	$7.95 \leq 10.96$	Sectional
		SectionExamination	$25 \leq 70.725$	Compact
		2. Inspection of Lateral and Bending Strong Effect	$L_b \leq L_b \text{ max,}$ with Moment Ratio :	Eligible
		3. Inspection of Beam Sliding	$0.17 < 1$ Ratio Shear : $0.0992 < 1$	Eligible
2	WF Beam 2 200 x 200 x 9 x 14	4. Bending and Shear Interaction Check	$0.232084 < 1.375$	Eligible
		1. Cross	$6.25 \leq 10.96$	Sectional
		SectionExamination	$20 \leq 70.725$	Compact
		2. Inspection of Lateral and Bending Strong Effect	$L_b \leq L_b \text{ max}$ Moment Ratio:	Eligible
3	ColoumnWF 400 x 400 x 30 x 50	3. Inspection of Beam Sliding	$0.0125 < 1$ Ratio Shear : $0.001 < 1$ $0.019739 < 1.375$	Eligible
		4. Bending and Shear Interaction Check		Eligible
		1. Examination of Slenderness of Section Column	Wings: $4 < 0.969$ Body : $0.0127 < 0.125$ Maka : $13.3 < 70.30$	Sectional Compact
		2. Examination of Slenderness of Column Elements	$L_b < L_b \text{ max}$	Eligible
		3. Capacity Check in Axial Column	$0.01297 < 1$ $172.8 > 14.332$	Eligible
		4. Sliding Examination OnColumn		

Angkur, Baseplat, and Connection

Analysis of Angkur and Baseplat which will be used in planning office buildings as follows:

Table 3. Table Analysis Angkur, Baseplate :

No	Profile Data	Control	Analysis Results	Description
1	Base Plate Plate Thickness : 25 mm	1. Style Axial Maximum	750.589 Kg	
			720.589 Kg	
		2. Lateral Style Minimum	87.5 Kg/mm ²	
		3. Prisoners Permint	N < d	
2	Angkur A-307 6 M25, Length of 400 mm		91.39 < 400 mm	Eligible
		4. Chek	B < bf	
			91.037 < 400 mm	Eligible
		1. Check Sliding Style	0.366 < 165 N/mm ²	Eligible
		2. Check Plate Resistance	0.288 < 216 N/mm ²	Eligible
		3. Chek Tensile Strength	152170.9 > 3638.975	

Table 4. Results table Connection Analysis

No	Profile Steel	Connections
1	Pilecap	A-307 6M25
2	Columns with Beams B1	Bolt A-325 16 M25
3	Columns with Beams B2	Bolt A-325 8 M25
5	Beams B1 with Beams B2	Bolt A-325 4 M25

CONCLUSION

Based on data analysis and discussion on the planning of 7-story office building + 1 ground floor, it can be concluded as follows:

1. Profiles used in the Preliminary design in the process of entering SAP analysis produce a value of 407 critical frames that must be changed in the steel profile.
2. Changes in profile and that will be used in the planning of this office building are:
Main beam / mains using profile of Steel WF 350 x 300 x 14 x 23, Child beam using Steel WF 200x 200x9x14 profile, For Columns using Profiles Steel WF 400x400x30 x50.
3. From SAP analysis then Check and control is carried out both on the main beam, beam, and Coloumn in axial, shear calculations. Moments produce structures that meet the requirements and are safe for use in office building structures.
4. In the anchor and baseplate discussion, the dimensions for anchor were obtained using M25 anchor with 400 mm anchor length, and 25 mm planning for baseplate with a thickness of.
5. At the connection structure of this building using a bolt connection, with the results of an analysis using M-25 bolts with the number of bolts 16.

Suggestions

Suggestions that the writer can convey with the results of the analysis that has been carried out about the building of a steel frame structure are:

1. Check and control again on the calculation of buildings and placement for these structures both on columns and beams,
2. Need analysis on structural stiffness building,
3. It is necessary to analyze the calculation for pile, sloof and pilecap foundations in the planning of the office building.

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