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ANALYSIS AND DESIGN USING BEAM CONSTRUTION OF THE PELITA BANGSA SCHOOL IN THE CIREBON CITY

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ABSTRACT

The success of the development from an area, which can be seen from the education level of the population. Increasingly developed education level of the population, it will be bring to the level of welfare for the population. Pelita Bangsa School Cirebon is a private school which has a ladder Play Group, Kindergarten, Elementary School, Junior High School and Senior High School, which is located in the city of Cirebon at the address on Terusan Laut Arafuru Street Blok A1 kavling . 6-7 Cirebon 45131 West Java.

The additional building facilities of Pelita Bangsa School will be investigated in this thesis which is about structural analysis and design using steel material with LRFD (Load Resistance Factor Design) system.

Analyze and design the construction of Pelita Bangsa School building with design code SNI-1729-2015 for building steel structures, SNI-1727-2013, PPPURG 1987 for loads and then SNI-1726-2012 for earthquake analysis.

Analyze the structure with the help of SAP2000 (Structure Analysis Program 2000) software and design the building of Sekolah Pelita Bangsa using steel material.

Keywords: Analysis and design structure, LRFD, steel material, SAP2000

1. PLERIMINARY

The success of the development from an area, which can be seen from the education level of the population. Increasingly developed education level of the population, it will be bring to the level of welfare for the population.

Improving the quality of human resources (HR) of them pursued through development in the field of education, especially through formal education. In the meantime, to improve education efforts made including increased the infrastructure and facilities in order to expand the range of services and opportunities to the community in education.

Based upon the care and attention on a variety of social problems that appear in the life of society, especially the problem of education is not only that concerning the capacity gaps educational institutions with quantity children of school age, but concerns are also based on delinquency airings children and adolescents, many of which originate the inability of the school indicated provide appropriate education and teaching, the Education Foundation Pelita Bangsa feel called and have a moral obligation to participate in thinking about these issues, called and agreed to provide a positive contribution to society by establishing Pelita Bangsa School.

Pelita Bangsa School Cirebon is a private school which has a ladder Play Group, Kindergarten, Elementary School, Junior High School and Senior High School, which is located in the city of Cirebon at the address on Terusan Laut Arafuru Street Blok A1 kavling . 6-7 Cirebon 45131 West Java.

From that case, the additional building facilities of Pelita Bangsa School will be investigated in this thesis which is about structural analysis and design using steel material with LRFD (Load Resistance Factor Design) system.

2. FOCUS THE PROBLEM

Analyze the structure with the help of SAP2000 (Structure Analysis Program 2000) software and design the building of Sekolah Pelita Bangsa using steel material.

3. BOUNDARY THE PROBLEM

a. Just analyze and design the construction of Pelita Bangsa School building with design code SNI-1729-2015 for building steel structures, SNI-1727-2013, PPPURG 1987 for loads and then SNI-1726-2012 for earthquake analysis;
b. Designing structure only the building area of the addition of facilities Pelita Bangsa School;
c. Not designing plumbing and electrical installations;
d. Not calculate load and structure of shear wall and stairs
e. Analyze the earthquakes, just calculate the static equivalent.
f. Just calculate the Cost Plan (RAB) structure;

4. FORMULATION OF THE PROBLEM

a. How to analyze the building of Pelita Bangsa School with the help of SAP2000 (Structure Analysis Program 2000) software?
b. How to design the building of Pelita Bangsa School using steel material with LRFD (Load and Resistance Factor Design) system?

5. RESEARCH PURPOSE

a. Knowing the results of building analysis of Pelita Bangsa School with the help of SAP2000 software;
b. Designing the building of Sekolah Pelita Bangsa using steel material with LRFD (Load and Resistance Factor Design) system.

6. FRAMEWORKS

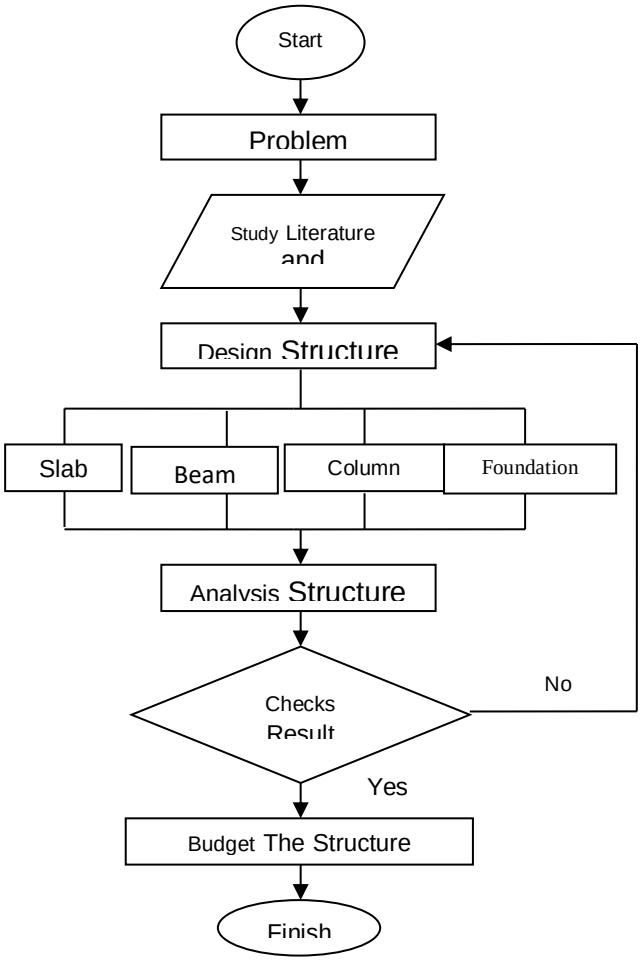

Figure 1. Flow Chart Frameworks

7. METHOD AND RESEARCH OBJECT

a. Preparation stage

The preparation stage is the stage preliminary, before doing the survey to research location, Pelita Bangsa School on Jl. Terusan Laut Arafuru Blok A1 Kavling 6-7 Cirebon.

The survey which doing, is to review the location and capture of documentation in Pelita Bangsa School building, the goal is for material research.

b. Problem stage

1. How is the capacity of the Pelita Bangsa School?
2. What impact are gained when student additions always occur?
3. How the solution from that problem?

c. Design stage

The stage of design the elements of the structure with manual, as follows :

1. Slab design
2. Beam design
3. Column design
4. Foundation design.

d. Analysis stage

1. Modeling the structure
2. Design the frame section structure, (slab, beam, column) without stairs
3. Calculate the loading system.
4. Calculate the dimension from structure
5. Not calculate load and structure of shear wall and stairs
6. Calculate the earthquake.

e. The budget planning stage

The budget planning of the structure, the calculation as follows :

Budget structure = volume structure x unit price.

8. RESEARCH RESULT AND DISCUSSION

In the design construction of adding the classroom using steel structure, and be found used structure profile at the construction adding the classroom, there are as follows:

Table 1. Design Construction

Type	Floors	Material	Dimension
Sloof	Based floor	Concrete	300x600 mm
Pedestal	Based floor	Concrete	400x400 mm
Beam A	Balok Induk	Steel	WF 350.175.7.11 mm
Beam B	Balok Anak 1	Steel	WF 300.150.6,5.9 mm
Beam C	Balok Anak 2	Steel	WF 250.125.6.9 mm
Column A	1st floor	Steel	HB 350.350.12.19 mm
Column B	2nd and 3rd floor	Steel	HB 250.250.9.14 mm
Column C	4th floor	Steel	HB 200.200.8.12 mm

a. Building Specification

1. Building function: Classroom
2. Building area: 526,832 m^2
3. Building height: 12,24 m (including dak roof)
4. Building Configuration:

Table 2. Building Configuration

No.	Building	Elevation (m)
1	1st floor	0
2	2nd floor	3,06
3	3rd floor	6,12
4	4th floor	9,18
5	Dak roof	12,24

b. Material Specification

1. Steel : BJ37, fy = 240 Mpa, fu = 370 Mpa
2. Concrete : K-350, f'c = 29,05 Mpa
3. Rebar : D ≥ 13 mm (fy = 400 Mpa), BJTD-40

   Ø ≤ 12 mm (fy = 240 Mpa), BJTD-24

c. Structure Design

1. Slab

The slab is planned from concrete, with the loads based into using of the floor and appropriate with SNI-1727-2013. The design of slab is view of two directions are x and y, from lx/ly will got the coeficient moment so can doing calculations to get the frame needed.

Table 3. Design of Slab

Position Floor	Thickness
1st floor	125 mm
2nd floor	125 mm
3rd floor	125 mm
4th floor	125 mm
Dak roof	100 mm

2. Beam and Column

In the design of beam and column, the loads is same witth slab, it is based on into using of the floor and appropriate with SNI-1729-2015.

- Column

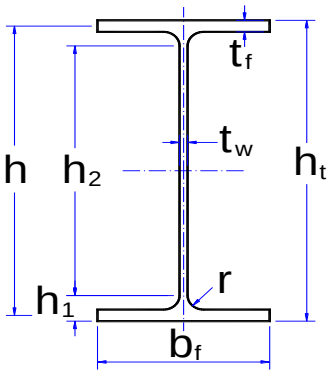

Figure 2. Column

1. Column A (HB 350.350.12.19)
2. Column B (HB 250.250.9.14)
3. Column C (HB 200.200.8.12)

- Beam

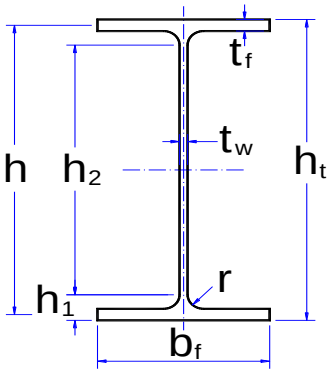

Figure 3. Beam

1. Beam A (I 350.175.7.11)
2. Beam B (I 300.150.6,5.9)
3. Beam C (I 250.125.6.9)

9. ANALYSIS STRUCTURE WITH SAP2000

a. Modeling Structure

In modeling structures with SAP2000, the first thing done is set the unit to be used for analysis. The unit used is kN.mm.C.

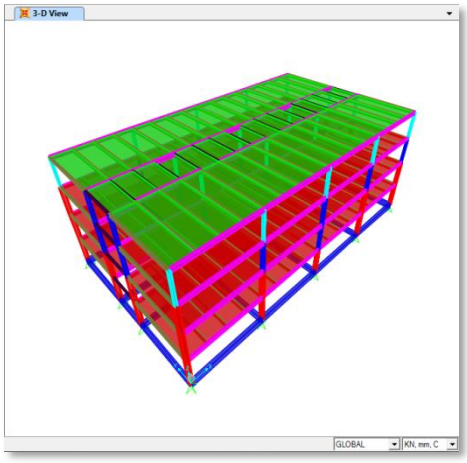

Figure 4. Modeling Structures with SAP2000

b. Define Materials Stucture

Material used are steel, for section property of beam and column. And then for section property of sloof (tie beam), slab and pedestal are used concrete material.

c. Define the Section Propertis

1. Sloof
   S (300 x 600) mm
2. Beam
   Beam A WF 350.175.7.11 mm
   Beam B WF 300.150.6,5.9 mm
   Beam C WF 250.125.6.9 mm
3. Column
   Column A HB 350.350.12.19 mm
   Column B HB 250.250.9.14 mm
   Column C HB 200.200.8.12 mm
4. Slab
   Slab 1^{st} – 4^{th}, h = 125 mm
   Dak roof, h = 100 mm

d. Define Loads

1. Dead Loads
2. Live Loads
3. Wall Loads
4. Wind Loads
5. Earthquake Load

- Define Load Combination :

The load combination based on SNI 1727 2013, in the analysis just used 6 (six) the main combination, the usual and commonly used in the structural analysis of the building, here are load combination will be input into SAP2000 :

1. 1,4D
2. 1,2D + 1,4L
3. 1,2D + 1,0Wx + L
4. 1,2D + 1,0Wy + L
5. 1,2D + 1,0Ex + L
6. 1,2D + 1,0Ey + L

10. Run Analysis SAP2000

- Select the load combination, inputted and then move to the right, in order the design and analysis by SAP2000.
- Edit reduction factor based on design code from AISC-LRFD99
- Choose the options from type of structure
- Run analysis SAP2000

11. Output Analysis SAP2000

❖ Display The Deformation Structure

Display > Show Deformed Shape

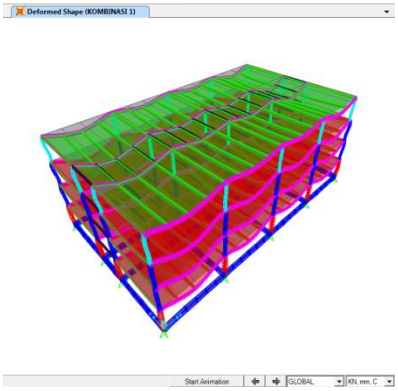

Figure 5. Deformation Structure

❖ Display The Restraint Reaction

Display > Show forces/Stress > Joint

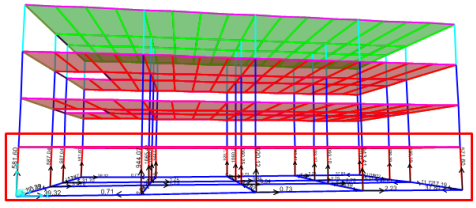

Figure 6. Restraint Reaction

❖ Display Forces

Display > Show forces/Stress > Frames/Cables

(1) Axial Force Diagram

(2) Shear Force 2-2 Diagram

(3) Shear Force 3-3 Diagram

(4) Moment 2-2 Diagram

(5) Moment 3-3 Diagram

❖ Output Earthquake Analysis (EQx & EQy) :

➢ Self Weight each floor (output SAP2000)

Table 4. Group 3 – Masses and Weights

TABLE: Groups 3 - Masses and Weights	
GroupName	**SelfWeight**
Text	KN
ALL	7508,982
Lantai 1	2626,99
Lantai 2	1740,954
Lantai 3	1710,823
Lantai 4 (dak)	1426,619

➢ Lateral force on each floor (F_x) :

➢ Calculate lateral force each floor :

Table 5. Calculate Lateral Force Each Floor

Lantai	Berat Tiap Lantai	Fx = 0,01 W x (kN)
Lantai 1	2626,99	26,2699
Lantai 2	1740,954	17,40954
Lantai 3	1710,823	17,10823
Lantai 4	1426,619	14,26619
Total	7505,386	75,05386

Check Analysis Structure

Design > Steel Frame Design > Start Design/Check of Structure

Color description :

- Blue : very safe (wasteful materials)
- Green : safe (saving materials)
- Yellow : safe (saving materials)
- Orange : danger / watch out (saving materials)
- Red : very danger (not recommended)

Design > Steel Frame Design > Verify All Member Passed

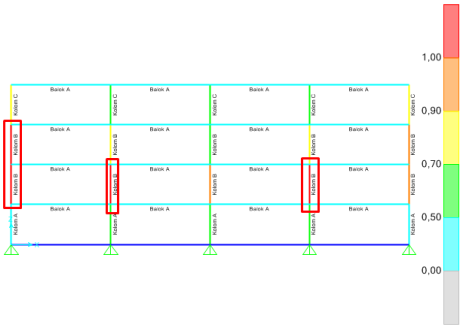

Figure 7. Alalysis Structure Coloum B (1)

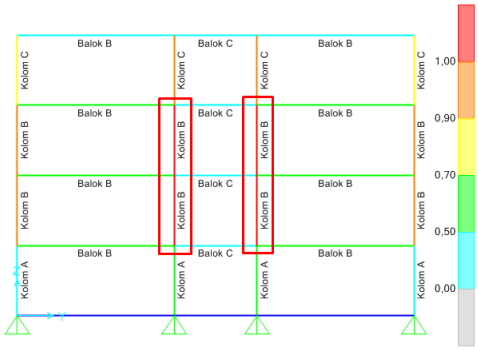

Figure 8. Analysis Structure Coloum B (2)

New Design Structure

Design > Steel Frame Design > Verify All Member Passed > Yes

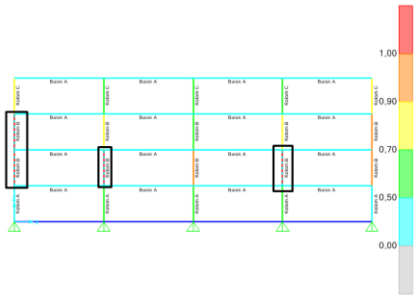

Figure 9. New Design Structure Coloum B (1)

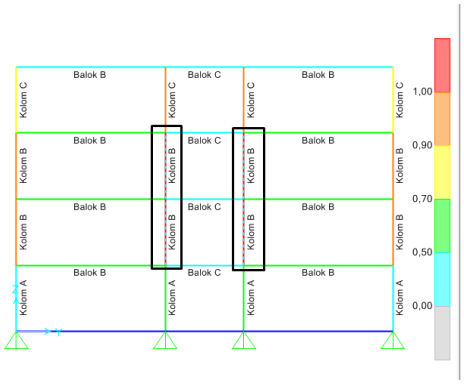

Figure 10. New Design Structure Coloum B (2)

Table 6. New Frame Design

Frame Saat Analisis			Frame Desain Baru		
Jenis Frame	Lantai Ke-	Jumlah	Jenis Frame	Lantai Ke-	Jumlah
Kolom B	2	14	Kolom A	2	14
	3	4		3	4
Total	-	18	Total	-	18

- Replacing frames that do not meet the capacity with larger frames of dimensions to make the structure more feasible. Ways to replace it are:
  Assign > Frame > Frame Sections
- After all the desired frames have been replaced, then re-do the analysis on the new structure. That is the same way in the previous analysis as follows:
  Analyze > Run Analysis > Run Now

Table 7. New Structure

Frame Saat Analisis			Frame Desain Baru		
Jenis Frame	Lantai Ke-	Jumlah	Jenis Frame	Lantai Ke-	Jumlah
Kolom B	2	14	Kolom A	2	14
	3	4		3	4
Total	-	18	Total	-	18

- Check the structural restructions to make sure there are no more inadequate frames in the new design. Like the previous analysis how to check the structure analysis in the following way:
  Design > Steel Frame Design > Start Design/Check of Structure
- After check the structure analysis then process to frame check is feasible and not feasible, that is by:
  Design > Steel Frame Design > Verify All Member Passed
- From the figure above shows that the results of the new design analysis there is no inadequate steel frame. So for this new design can be used as a structure for the school function at the building of Sekolah Pelita Bangsa.

CONCLUSION

1. In analyzing the structure with SAP2000, the steps that must be done consists of modeling the structure, define material, define and design frame section, define the load patterns and run analysis model of the structure.
2. The results from the analysis are internal forces (moment, axial and shear) that will be used in the design phase of the structure.
3. The result from analysis lateral force (earthquake), it can concluded the lateral force greatest is 26,2699 kN.
4. The result of analysis structure using SAP2000 for the design of the project data there are several frames that are repleced as follows:
5. After replacing multiple results frame of the new design analysis there is no inadequate steel frame. So for this new design can be used as a structure for the school function at the building of Sekolah Pelita Bangsa.
6. The vertical load of pile group is 70,074 kN, less then more from the maximum load permitted is 1128,704 kN, it can be concluded that the foundation in Sekolah Pelita Bangsa is safe.

7. From the result budget of the structures, it can be total budget structures is Rp 6,253,768,965.98,-

RECOMMENDATION

1. In conducting analysis using SAP2000 needed preliminary design and accurate when inputted the data (material, section properties and loads).
2. Regarding the design of the structure, to be note the design code (standar perencanaan).

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