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BEHAVIOR OF FLAT REINFORCED-CONCRETE COLUMN SIZE (15x30) CM TO AXIAL CYCLIC LOADING : COMPARATION STUDY COLUMN WITH REINFORCEMENT AND STEEL PROFILE

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ABSTRACT
This research discusses the behavior of flat columns with the comparison of reinforced-concrete columns and IWF steel reinforcement. The research object took 4 column samples with a column size of 15x30 cm by comparing the reinforced-concrete column and concrete columns with IWF steel reinforcement. This study conducted comparisons with experimental tests, column capacity theory calculations, and calculations with the ANSYS19.2 program. The purpose of this study was to obtain the maximum axial load result, shorten the column, the relationship between stress and strain of the column, failure pattern of the column, and the ability of the column to withstand the number of floors in the sample of the reinforced-concrete column and concrete columns with IWF steel reinforcement. The results of the average maximum axial load of the test object for each sample column in the experimental test for K1 is 119,6 tons, K2 is 146,18 tons, K3 is 146,6 tons, and K4 is 167,46 tons, the maximum axial load in the column capacity calculation for column sample K1 is 130 tons, K2 is 159 tons, K3 is 157 tons, and K4 is 180 tons, and the maximum axial load in the ANSYS 19.2 program for column sample K1 is 122,7 tons, K2 is 138,86 tons, K3 is 150,14 tons, and K4 is 159,62 tons. The failure pattern occurred in column sample K1 is in the column span area, for sample K2 in the column span and pedestal area, the K3 column in the pedestal area, and the K4 column in the pedestal area. K1 column sample withstand 2-floors, K2 and K3 columns withstand 3-floors, and K4 column withstand 4-floors.
Keyword: ANSYS 19.2, Experimental, Flat Column, Limit Capacity

INTRODUCTION

The development of construction in Indonesia is growing rapidly in line with the increasing need for infrastructure and other facilities to support the activities of the Indonesian (Pribadi et al., 2021). In accordance with its use, it would be better if the manufacturing process was faster, therefore this research study to design and plan the construction using a system of concrete column structure with IWF steel reinforcement (Shin & Park, 2022).

The concrete structure with IWF steel reinforcement is a construction consisting of two materials of different types or quality such as concrete and steel, which work together to form a single construction unit (monolid).

Along with the advances in building design, owners and architects desire the structural column flush with the wall or flat column but has a strong structural capacity in multi-story building designs, then the use of structural concrete column with IWF steel reinforcement can be a solution to reduce the size of the column to flattening in multi-story building.

The use of flat columns is to make the room more spacious, so this study conducted an analysis by comparing reinforced-concrete flat column and concrete columns with IWF steel reinforcement with pure axial load to determine the performance of these columns.

Objective of the Study

a. To determine the perfomance and behavior of reinforced-concrete flat column size (15x30) cm compared with a concrete column with IWF steel reinforcement.
b. To determine the maximum load (number of floors) that can be supported by reinforced-concrete flat-column and reinforced-concrete columns with IWF steel profiles.

Scope and Limitation

a. The samples were carried out using 15x30 cm column dimensions and using f'c 25 MPa concrete capacity.
b. The diameter of the steel bar for the main reinforcement uses D10 threaded rebar and plain D8 stirrup reinforcement.
c. Structural steel grade use fy 240 MPa.
d. Column load calculation only takes into account the static axial load without taking into account the moment and shear on the column.
e. Analysis of the column sample using experimental tests and analyzed with the ANSYS 19.2 and ETABS programs.

Significance of the Study

a. The use of concrete-columns with IWF steel reinforcement can reduce the size of the columns in multi-story buildings.
b. The use of flat concrete columns of size (15x30) cm with IWF steel reinforcement can make the construction time of multi-story building faster because, at the time of construction, steel columns and steel beams are fabricated and erected so that after the steel column stands upright formwork is installed and cast on the column.

METHOD OF RESEARCH

The stages of research on flat-concrete columns and concrete columns with IWF steel-reinforcement can be seen in the following flow chart:

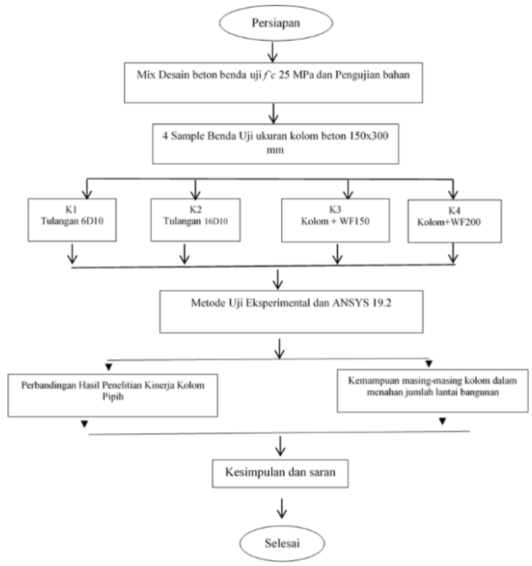


Figure 1 Research Flow Chart Diagram

Concrete and Steel Quality

Quality of concrete *Fc'*25 MPa
Steel Reinforcement Quality f_y *400* MPa
Structural Steel Grades f_y400 MPa

Experimental Method

Column sample testing in experimental testing is carried out after 28 days of concrete age (Frappa et al., 2022). Testing column samples using an UTM machine with a capacity of 2000 kN. UTM machine can be seen in Figure 7. The axial concrete column compression test method is based on SNI 03-2491-2002.

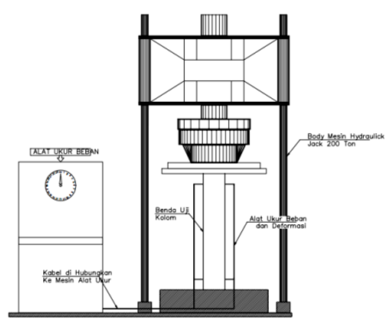


Figure 2 UTM Machine 200 Ton

The load on the 200 Ton UTM machine is carried out continuously with a constant loading speed ranging from 0,7 to 1,4 MPa per minute until the specimen is crushed (Lu et al., 2019). The loading speed for the test object in the form of a 15x30 cm column ranged from 50 to 100 kN per minute (Obermayr et al., 2015). The loading is carried out until the specimen is crushed and records the maximum axial load that occurs during the test (Elchalakani & Ma, 2017). Note the value of shortening of the concrete in the longitudinal (axial) direction as measured by the LVDT/ load and deformation measuring instrument (Fang et al., 2023).

Numerical Method with ANSYS 19.2 Program

The finite element method is a numerical analysis used in solving technical problem such as differential and integral equations with the approach metod.

An explanation of the elements and materials used as the sample reinforced-concrete column and concrete column reinforced with IWF steel is described as follows.

a. Concrete Material Model

The concrete is modeled using solid 65-8 nodes elements, as shown in Figure 8. This element has a degree of freedom (DOF) in the form of translation UX, UY, and UZ. ANSYS Material Reference recommends modeling concrete using these elements to solve convergence and plasticity problems after concrete failure.

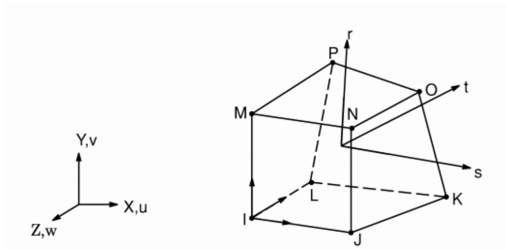


Figure 3 Element Model Solid 65

b. Steel Bar Material Model

Steel reinforcement is modeled using LINK 180-2 nodes line elements, as shown in Figure 9. This element is a compressive uniaxial element with DOF translation of UX, UY, and UZ on each node.

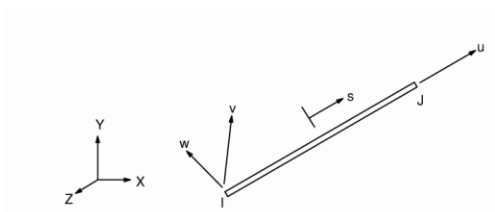


Figure 4 Element Model LINK 180

c. Structural Steel Material Model

The IWF steel material is modeled using SOLID 185-8 nodes elements, as shown in Figure 10. This element has DOF translation UX, UY, and UZ on each node.

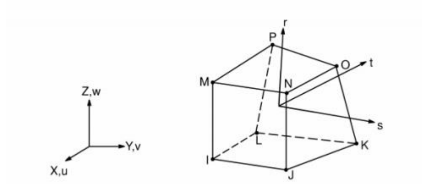
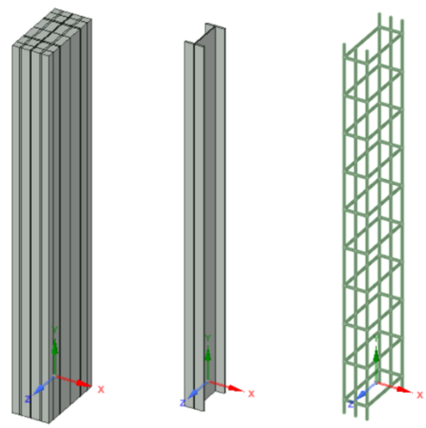


Figure 5 Element Model

d. Geometry Model

Geometry is modeled in 3 dimensions using ANSYS 19.2 program. Concrete is modeled using element solid 65, structural steel is modeled using element solid 185, and reinforcing steel is modeled using element link 180.



Concrete-*Solid 65* Steel-*Solid 185* Steel Bar-L*ink 180*

Figure 6 Geometry models of concrete, steel and reinforcement.

RESULTS AND DISCUSSION

This study discusses the performance of flat column size of 15x30 cm compared to concrete columns with IWF steel-reinforcement and determines the ability of each type of column sample to withstand the number of building floors.

Comparison of Axial Maximum Load Results in Experimental Tests Method and Cross-sectional Capacity Theory

The maximum axial load capacity of the reinforced-concrete column and IWF steel-reinforced concrete column will be compared to the results of experimental tests and limit capacity theory.

Table 1 Recapitulation of Maximum Load on Column Sample with the Experimental Tests and Limit Capacity Theory

No.	Column Sample	Experimental Tests (Ton) (1)	Limit Capacity Theory Calculation (Ton) (2)	Comparison between Experimental Test and Capacity Theory (%) (3) = (2-1/1 *100%)
1	Column K1	119.6	130	8.70
2	Column K2	146.18	159	8.77

3	Column K3	146.6	157	7.09
4	Column K4	167.46	180	7.49

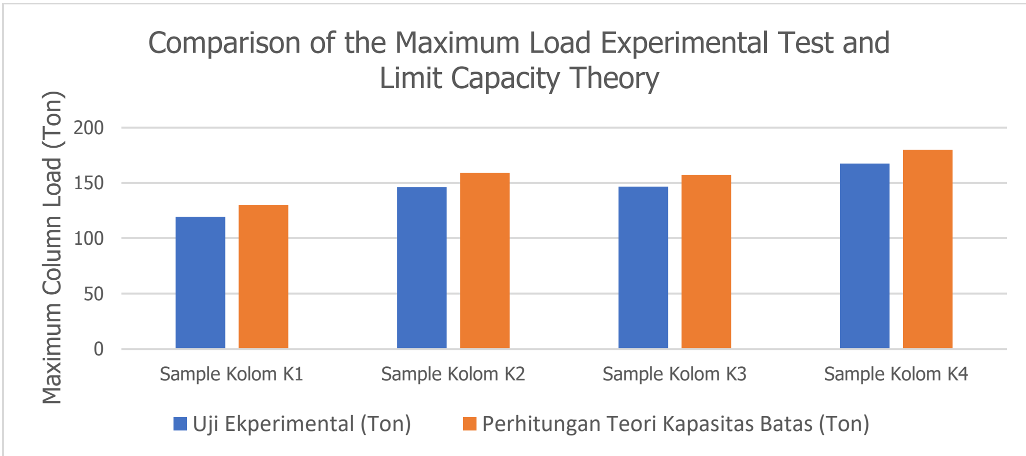


Figure 7 Comparison of the Average Maximum Load Experimental Test and Limit Capacity Theory in Column Sample

Based on the tables and graphs from the results of the comparison between maximum load obtained in the experimental test and theoretical calculation of the column, it can be discussed as follows:

a. Column K1 in the experimental test and the theoretical calculation 119,6 tons and 130 tons, the percentage difference is 8,07%.
b. Column K2 in the experimental test and the theoretical calculation 146,18 tons and 159 tons, the percentage difference is 8,77%.
c. Column K3 in the experimental test and the theoretical calculation 146,6 tons and 157 tons, the percentage difference is 7,09%.
d. Column K4 in the experimental test and the theoretical calculation 167,46 tons and 180 tons, the percentage difference is 7,49%.

Based on the test results on the type of column sample in the experimental test and limit capacity theoretical calculation that the largest maximum axial load occurs in the limit capacity theoretical calculation (Cui et al., 2022). The difference in the value of the axial load can be described as follows; the sample testing process, setting out the column in the experimental test, the mixing process of the aggregates is not homogenous, and the concrete compressive testing tool pressing with a speed (50-100) kN/minute so that the slower the speed of the machine the smaller maximum axial load experimental test value.

Comparison of Maximum Axial Load Results in Experimental and Computational Test using ANSYS 19.2 Program

Maximum axial load capacity on the reinforced concrete column and IWF steel-reinforced concrete columns will be compared to the results of the experimental and computational test using the ANSYS 19.2 program.

Table 2 Recapitulation of Maximum Load on Column Sample with the Experimental Tests and Computational Result Using ANSYS 19.2 Program

No.	Column Sample (1)	Experimental Test (Ton) (2)	ANSYS 19.2 Computation (Ton) (3)	Comparison between Experimental Tests and ANSYS 19.2 Computation (%) (4)=(2-3/2 *100%)
1	Column K1	119.6	122.7	2.59
2	Column K2	146.18	138.86	5.01
3	Column K3	146.6	150.14	2.41
4	Column K4	167.46	159.62	4.68

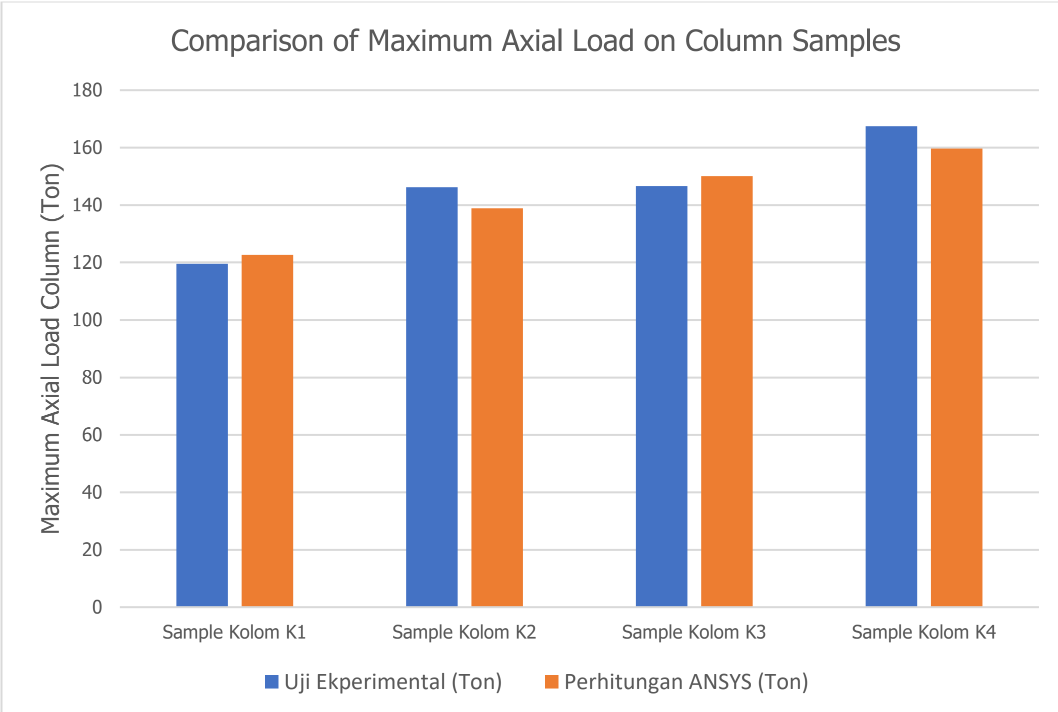


Figure 8 Comparison of the Average Maximum Load Experimental Test and ANSYS 19.2 Computation in Column Samples

Based on the tables and graphs from the results of the comparison of the maximum load obtained in the experimental test and ANSYS 19.2 computation, it can be discussed as follows:

a. Column K1 in the experimental and computational test using ANSYS 19.2 program was 119,6 tons and 122,7 tons, the percentage difference was 2,59%.
b. Column K2 in the experimental and computational test using ANSYS 19.2 program was 146,18 tons and 138,86 tons, the percentage difference was 5,01%.
c. Column K3 in the experimental and computational test using ANSYS 19.2 program was 146,6 tons and 150,14 tons, the percentage difference was 2,41%.
d. Column K4 in the experimental and computational test using ANSYS 19.2 program was 167,46 tons and 159,62 tons, the percentage difference was 4,68%.

Based on the comparative result between experimental and computational test using ANSYS 19.2 program, then it can be seen that the largest maximum load occurs in the ANSYS computation on the sample columns K1 and K3 (Bjerkeli, 2021). The difference in the value can be described as follows; sample testing process, setting out the column inthe experimental test, and the mixing process of the aggregates is not homogenous (Bridgwater, 2012).

Comparative Results of Shortening Column on ANSYS 19.2 Computation and Experimental Test Based on Maximum Axial Load

For column shortening values on reinforced concrete columns and concrete columns with IWF steel reinforcement based on the maximum axial load that occurs will be discussed in each type of column sample (Hassanein & Patel, 2018).

Table 3 Comparison of Shortening Column between Experimental and Computational Test using ANSYS 19.2 Program

No.	Column Sample	Shorten column in ANSYS 19,2 Computation (mm) (2)	Shorten Column in Experimental Test (mm) (3)	Shorten Column Comparison (%) (3-2/2*100%)
1	Column K1	8.2064	7.07	16.07%
2	Column K2	6.5	7.94	18.14%
3	Column K3	7	8.39	16.57%
4	Column K4	6.2	8.65	28.32%

Maximum axial load in column K1 that occurs in the experimental and computational test of ANSYS 19.2 when the condition of the column K1 failure, shortening column occurs by 7,07 mm and 8,2064 mm.

Maximum axial load in column K2 that occurs in the experimental and computational test of ANSYS 19.2 when the condition of the column K2 failure, shortening column occurs by 7,94 mm and 6,5 mm.

Maximum axial load in column K3 that occurs in the experimental and computational test of ANSYS 19.2 when the condition of the column K3 failure, shortening column occurs by 8,39 mm and 7 mm.

Maximum axial load in column K4 that occurs in the experimental and computational test of ANSYS 19.2 when the condition of the column K4 failure, shortening column occurs by 8,65 mm and 6,2 mm.

Based on the test results of column shortening, it can be seen that the greater the maximum axial load that occurs, the large column shortening value.

Comparative Results of the Relationship between Stress and Strain in Column K1 with Experimental Test and ANSYS 19.2 Computation

a. Column K1

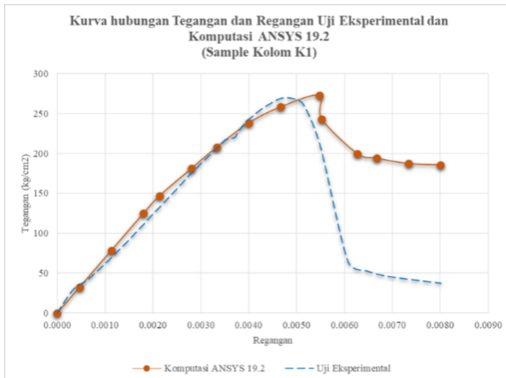


Figure 9 Stress-Strain Relationship Column K1

The stress value that occurs due to the maximum axial load in the experimental test is 269,67 kg/cm^2 and the strain value is 0,004713. The stress value that occurs due to the maximum axial load on the ANSYS 19.2 computation is 272,67 kg/cm^2 and the strain value is 0,005471.

It can be concluded that the greatest value of stress-strain occurs in ANSYS 19.2 computation (Kumar et al., 2022). The stress value is obtained based on the maximum axial load value divided by the column sample area (Wang et al., 2012).

Based on the maximum axial load in the ANSYS 19.2 computation and experimental tests, it is found that the largest maximum axial load occurs in the ANSYS 19.2 computation (Ha & Jeong, 2021). This causes the stress value in the ANSYS 19.2 computation greater than the experimental test, while the strain value affects the shortening of the column divided by the length of the column sample (Rahmzadeh et al., 2021). It can be seen that shortening the column in the ANSYS 19.2 computation has a greater value than the experimental test and it causes the strain value in the ANSYS 19.2 greater than the experimental test.

b. Column K2

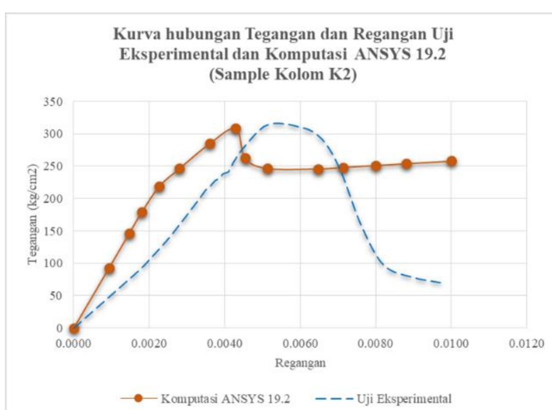


Figure 10 Stress-Strain Relationship Column K2

The stress value that occurs due to the maximum axial load in the experimental test is 315,89 kg/cm^2 and the strain value is 0,005293. The stress value that occurs due to the maximum axial load on the ANSYS 19.2 computation is 308,58 kg/cm^2 and the strain value is 0,004291.

It can be concluded that the greatest value of stress-strain occurred in the experimental test (Samani & Attard, 2012). The stress value is obtained based on the maximum axial load value divided by the column sample area (Tripura & Singh, 2015).

Based on the maximum axial load in the ANSYS 19.2 computation and experimental tests, it is found that the largest maximum axial load occurs in the experimental test. This causes the stress value in the experimental test greater than the ANSYS 19.2 computation, while the strain value affects the shortening of the column divided by the length of the column sample. It can be seen that shortening the column in the experimental test has a greater value than the ANSYS 19.2 computation and it causes the strain value in the experimental test greater than the ANSYS 19.2 computation.

c. Column K3

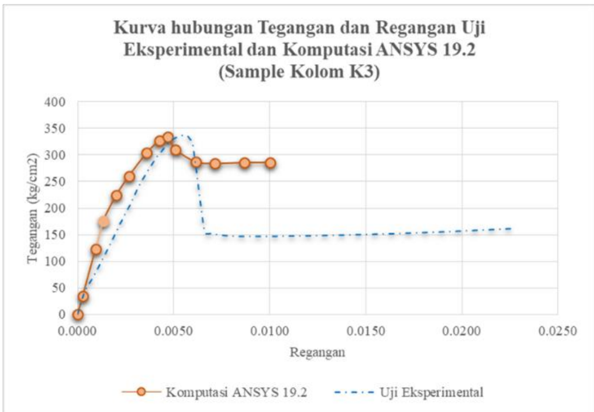


Figure 11 Stress-Strain Relationship Column K3

The stress value that occurs due to the maximum axial load in the experimental test is 336,22 kg/cm^2 and the strain value is 0,005593. The stress value that occurs due to the maximum axial load on the ANSYS 19.2 computation is 333,64 kg/cm^2 and the strain value is 0,004667.

It can be concluded that the greatest value of stress-strain occurred in the experimental test. The stress value is obtained based on the maximum axial load value divided by the column sample area.

Based on the maximum axial load in the ANSYS 19.2 computation and experimental tests, it is found that the largest maximum axial load occurs in the experimental test. This causes the stress value in the experimental test greater than the ANSYS 19.2 computation, while the strain value affects the shortening of the column divided by the length of the column sample. It can be seen that shortening the column in the experimental test has a greater value than the ANSYS 19.2 computation and it causes the strain value in the experimental test greater than the ANSYS 19.2 computation.

d. Column K4

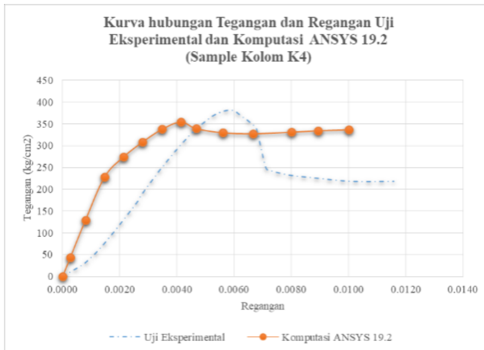


Figure 12 Stress-Strain Relationship K4

The stress value that occurs due to the maximum axial load in the experimental test is 380,89 kg/cm^2 and the strain value is 0,005767. The stress value that occurs due to the maximum axial load on the ANSYS 19.2 computation is 354,71 kg/cm^2 and the strain value is 0,004133.

It can be concluded that the greatest value of stress-strain occurred in the experimental test. The stress value is obtained based on the maximum axial load value divided by the column sample area.

Based on the maximum axial load in the ANSYS 19.2 computation and experimental tests, it is found that the largest maximum axial load occurs in the experimental test. This causes the stress value in the experimental test greater than the ANSYS 19.2 computation, while the strain value affects the shortening of the column divided by the length of the column sample. It can be seen that shortening the column in the experimental test has a greater value than the ANSYS 19.2 computation and it causes the strain value in the experimental test greater than the ANSYS 19.2 computation.

The difference in stress and strain values in the ultimate and post-ultimate conditions in the experimental test and computational ANSYS 19.2 test is the effect of time on the concrete compressive test machine in the experimental test with a speed of 50-100 kN/minute. This time parameter gives a dynamic effect which results in a sudden large loss of strength due to post-ultimate, while the ANSYS 19.2 computation is static and not time-based. Concrete retains its shape to withstand loads and there are no fractures/ failures. This resulted in the ANSYS 19.2 computation of post-ultimate value being larger than the result in the experimental test.

Column Failure Pattern in Reinforced Concrete Column Sample and Concrete Columns with IWF Steel Reinforcement

Colum Sample K1

The failure pattern that occurs in the experimental test results is in the center span of the column or the column field area. As well as the experimental test failure pattern, the failure pattern of ANSYS 19.2 computation is in the center span of the column or the column field area.

Column Sample K2

The failure pattern that occurs in the experimental test results is in the pedestal area of the column sample. As well as the experimental test failure pattern, the failure pattern of ANSYS 19.2 computation is in the pedestal area.

Column Sample K3

The failure pattern that occurs in the experimental test results is in the pedestal area of the column sample. As well as the experimental test failure pattern, the failure pattern of ANSYS 19.2 computation is in the pedestal area.

Column Sample K4

The failure pattern that occurs in the experimental test results is in the pedestal area of the column sample. As well as the experimental test failure pattern, the failure pattern of ANSYS 19.2 computation is in the pedestal area.

The Capacity of the Flat Column to Withstand the Number of Building Floors in the Reinforced-Concrete Column Sample and IWF Steel-reinforcement Concrete Column Sample

The capacity of the flat-column to withstand the number of building floors is analyzed by taking an example of a building plan such as a boarding house. The calculation to determine the capacity of column types to withstand the number of building floors assisted by the ETABS program. The ETABS program is used specifically for the analysis of high-rise building structures such as hospital buildings, offices, apartments, etc.

The building data are as follows :

Building Function : Rumah Kos
Concrete Grade : f'c 25 MPa
Steel-bar Grade : 400 MPa
Structural Steel Grade: 240 MPa
Location : Jakarta

The rules used in boarding house buildings are:

- Earthquake Resistance Planning Procedures for Building (Tata Cara Perencanaan Ketahanan Gempa untuk Bangunan Gedung) SNI 1726: 2012
- Minimum Load for Building Design (Beban Mimimum untuk Perancangan Bangunan Gedung) SNI 1727 -2013
- Calculation Procedures for Concrete Structures for Buildings (Tata Cara Perhitungan Struktur Beton untuk Bangunan Gedung) SNI 2847-2013

The loading:

- Dead Load (Finishing, Plafond, and M/E)
- Live Load (boarding house buildings load 250 kg/m2)
- Wind Load (39.9 m/s)
- Earthquake Load

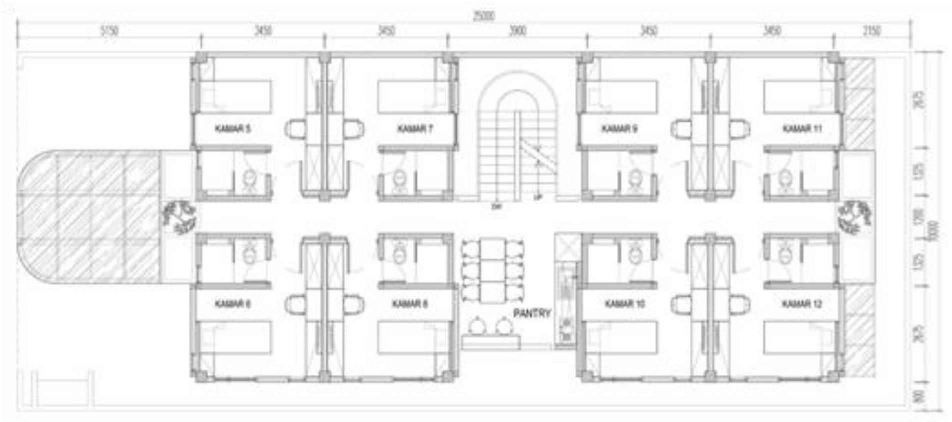


Figure 13 Boarding House Building Plan

a. Column Sample K1

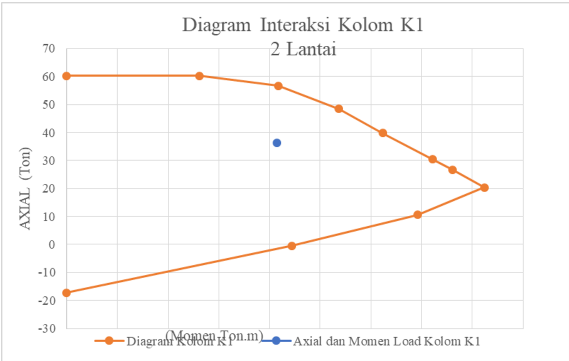


Figure 14 K1 Column Interaction Diagram of a 2-story Building

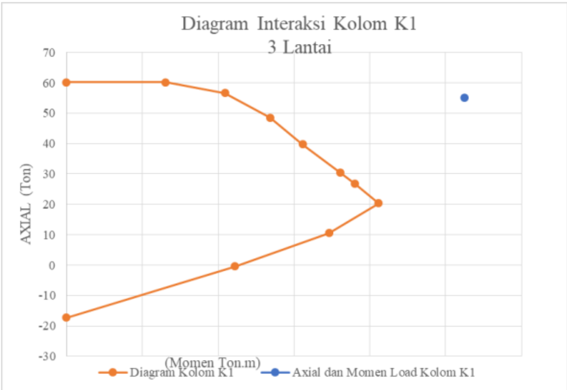


Figure 15 K1 Column Interaction Diagram of 3-story Building

Column sample K1 was analyzed with ETABS software for 2-story and 3-story buildings. It was found that the K1 sample column could withstand a 2-story building by looking at the interaction diagram and by inputting the axial and moment values that occurred in a 2-story building in column sample K1.

b. Column Sample K2

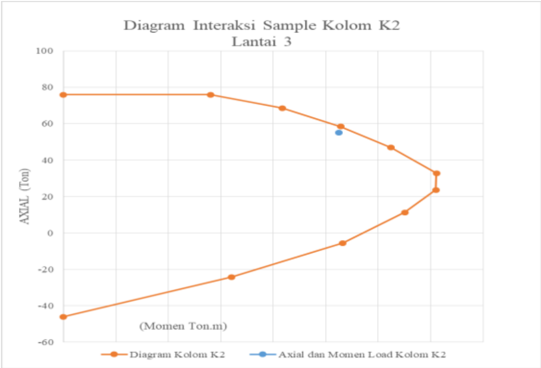


Figure 16 K2 Column Interaction Diagram of a 3-story Building

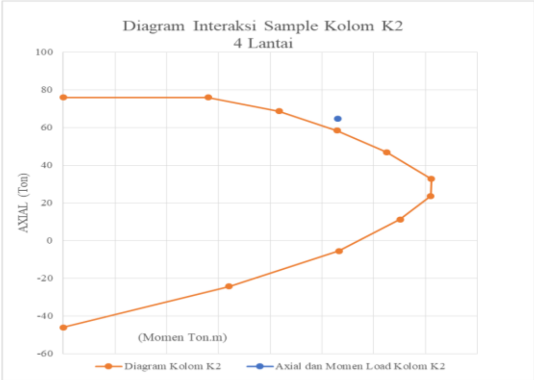


Figure 17 K2 Column Interaction Diagram of a 4-story Building

Column sample K2 was analyzed with ETABS software for 3-story and 4-story buildings. It was found that the K2 sample column could withstand a 3-story building by looking at the interaction diagram and by inputting the axial and moment values that occurred in a 3-story building in column sample K2.

c. Column Sample K3

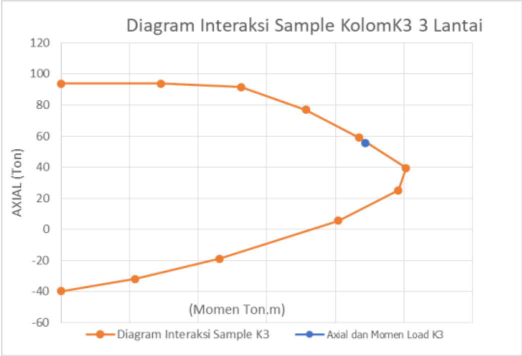


Figure 18 K3 Column Interaction Diagram of a 3-story Building

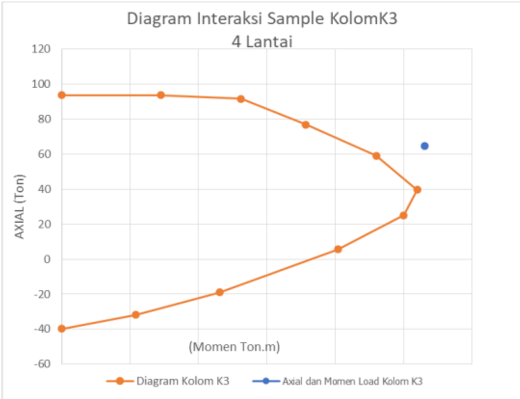


Figure 19 K3 Column Interaction Diagram of a 4-story Building

Column sample K3 was analyzed with ETABS software for 3-story and 4-story buildings. It was found that the K3 sample column could withstand a 3-story building by looking at the interaction diagram and by inputting the axial and moment values that occurred in a 3-story building in column sample K3.

d. Column Sample K4

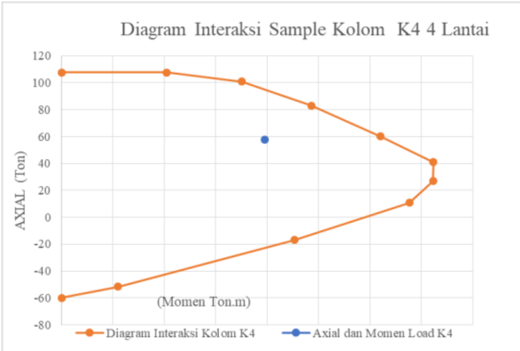


Figure 20 K4 Column Interaction Diagram of a 4-story Building

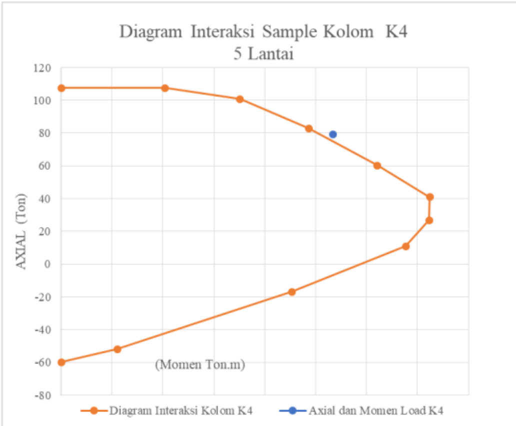


Figure 21 K4 Column Interaction Diagram of a 5-story Building

Column sample K4 was analyzed with ETABS software for 4-story and 5-story buildings. It was found that the K4 sample column could withstand a 4-story building by looking at the interaction diagram and by inputting the axial and moment values that occurred in a 4-story building in column sample K4.

CONCLUSION

The performance of the flat column size of 15x30 cm in the column samples are as follows: a. The comparison value of the maximum axial load on the column sample between the experimental test and the limit capacity theory Column K1 in the experimental test and the theoretical calculation of limit capacity theory are 119,6 tonnes and 130 tonnes, and the percentage difference is 8,07%. Column K2 in the experimental test and the theoretical calculation of limit capacity theory are 146,18 tonnes and 159 tonnes, and the percentage difference is 8,77%. Column K3 in the experimental test and the theoretical calculation of limit capacity theory are 146,6 tonnes and 157 tonnes, and the percentage difference is 7,09%. Column K4 in the experimental test and the theoretical calculation of limit capacity theory are 167,46 tonnes and 180 tonnes, and the percentage difference is 7,49%. b. Comparison of the maximum axial load on the column sample between the experimental test and ANSYS 19.2 computation Column K1 in the experimental test and ANSYS 19.2 computation are 119,6 tonnes and 122,7 tonnes, and the percentage difference is 2,59%. Column K1 in the experimental test and ANSYS 19.2 computation are 146,18 tonnes and 138,86 tonnes, and the percentage difference is 5,01%. Column K3 in the experimental test and ANSYS 19.2 computation are 146,6 tonnes and 150,14 tonnes, and the percentage difference is 2,41%. Column K4 in the experimental test and ANSYS 19.2 computation are 167,46 tonnes and 159,62 tonnes, and the percentage difference is 4,68%. c. Comparison value of shortening column between ANSYS 19.2 Computation and Experimental Test The shortening value of column K1 at maximum axial load in the experimental test and computational test of ANSYS 19.2 is 7,07 mm and 8,2064 mm, with a percentage difference of 16,07%. The shortening value of column K2 at maximum axial load in the experimental test and computational test of ANSYS 19.2 is 7,94 mm and 6,5 mm, with a percentage difference of 18,14%. The shortening value of column K3 at maximum axial load in the experimental test and computational test of ANSYS 19.2 is 8,39 mm and 7 mm, with a percentage difference of 16,57%. The shortening value of column K4 at maximum axial load in the experimental test and computational test of ANSYS 19.2 is 8,65 mm and 6,2 mm, with a percentage difference of 28,32%. d. Stress-strain comparison values between ANSYS 19.2 Computation and Experimental Test The stress value in Column K1 that occurs due to the maximum axial load in the experimental test is 269,67 kg/cm^2 and the strain value is 0,004713, while the ANSYS 19.2 computation is 272,67 kg/cm^2 and the strain is 0,005471.It can be concluded that the greatest value of stress-strain occurs in ANSYS 19.2 computation. The stress value in Column K2 that occurs due to the maximum axial load in the experimental test is 315,89 kg/cm^2 and the strain value is 0,005293, while the ANSYS 19.2 computation is 308,58 kg/cm^2 and the strain is 0,004291. It can be concluded that the greatest value of stress-strain occurs in experimental test. The stress value in Column K3 that occurs due to the maximum axial load in the experimental test is 336,22 kg/cm^2 and the strain value is 0,005593, while the ANSYS 19.2 computation is 333,64 kg/cm^2 and the strain is 0,004667. It can be concluded that the greatest value of stress-strain occurs in experimental test. The stress value in Column K4 that occurs due to the maximum axial load in the experimental test is 380,89 kg/cm^2 and the strain value is 0,005767, while the ANSYS 19.2 computation is 354,71 kg/cm^2 and the strain is 0,004133. It can be concluded that the greatest value of stress-strain occurs in experimental test. e.The column failure pattern that occurs in each column sample when the maximum stress occurs can be summarized as follows: The K1 column sample in the experimental test and ANSYS 19.2 computation cracks occurred in the center of the column span. The K2 column sample in the experimental test and ANSYS 19.2 computation cracks occurred in the area between the center of the column span to the end of the pedestal column. The K3 column sample in the experimental test and ANSYS 19.2 computation cracks occurred in the area between the column span to the pedestal column. The K4 column sample in the experimental test and ANSYS 19.2 computation cracks occurred in the area between the column span to the pedestal column. Based on the calculation of each column capacity to withstand the number of floors of the building, it can be concluded as follows: The column sample K1 can withstand a 2-story building. The column sample K2 can withstand a 3-story building. The column sample K3 can withstand a 3-story building. The column sample K4 can withstand a 4-story building. The column sample K2 and K3 have the same capacity, that it can withstand a 3-story building, but from the implementation perspective, it is better to use a column K3. If using column K2, the joint connection between the beam and the column will result in the build-up of reinforcement which causes difficulties in construction.

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