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Short Column Analysis with and Without Strengthening Reinforced Polymer Carbon Fiber and Reinforced Polymer Glass Fiber With Axial Loading

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SHORT COLUMN ANALYSIS WITH AND WITHOUT STRENGTHENING REINFORCED POLYMER CARBON FIBER AND REINFORCED POLYMER GLASS FIBER WITH AXIAL LOADING

ABSTRACT

Increasing the compressive strength of the column without changing the significant cross-sectional dimension is needed by the planner in planning the existing building or building under construction. Experiments on this thesis were conducted to see the increase of compressive strength of reinforced concrete columns before and after coated with carbon fiber wrap and glass fiber wrap, and to observe the collapse pattern that occurred on the test specimen column. The test was performed with 6 (six) test specimens of 2 (two) test specimens measuring 12 cm x 12 cm x 158 cm, concrete quality of K-225 or f'c 19 MPa. Other test objects as much as 2 (two) pieces using the dimensions of 12 cm x 12 cm x 158 cm, using the quality of concrete K-225 or f'c 19 MPa plus layer of carbon fiber type wrap 1 (one) layer with a thickness of 0.129 mm. The last 2 test pieces are 2 (two) pieces using dimensions of 12 cm x 12 cm x 158 cm, using the quality of K-225 or f'c 19 MPa concrete plus glass fiber layer thickness 2.6 mm.
Test object I, a reinforced concrete column of K 225 or f'c = 19 MPa, collapsed in compressive strength of reading 140 kg / cm2 or at a load of 21.42 Ton, with a strain of 0.85 $^{0}/_{00}$. Test object II, a reinforced concrete column of K 225 or f'c = 19 MPa, collapsed in compressive strength of 120 kg / cm2 readings or at 18.36 Ton load, with a strain of 1,1 $^{0}/_{00}$. Test object III, reinforced concrete column K 225 or f'c = 19 MPa, reinforced by using Carbon Fiber Wrap 1 (one) thick layer of 0.129 mm experiencing collapse at compressive strength of reading 260 kg / cm2 or at load of 39,78 Ton, with a strain of 1.8 $^{0}/_{00}$. Test object IV, concrete reinforced concrete columns K 225 or f'c = 19 MPa, reinforced by using Carbon Fiber Wrap 1 (one) layer with 0.129 mm thick experiencing collapse at compressive strength reading 220 kg / cm2 or at load 33,66 Ton , with a strain of 2.37 $^{0}/_{00}$. Test object V, reinforced concrete columns K 225 or f'c = 19 MPa, reinforced by using Glass Fiber Wrap 2 (two) layers with 2.6 mm thick have collapsed on compressive strength of reading 320 kg / cm2 or at load 48, 96 Ton, with a strain of 2.27 $^{0}/_{00}$. Test object VI, concrete reinforced concrete columns K 225 or f'c = 19 MPa, reinforced using Glass Fiber Wrap 2 (two) layers with 2.6 mm thick have collapsed on compressive strength of reading 340 kg / cm2 or at load 52, 02 Ton, with a strain of 2.29 $^{0}/_{00}$.
The columns coated with carbon and glass fiber wrap can increase the compressive strength of reinforced concrete columns. Carbon fiber wrap has a greater elasticity of fiber glass type wrap.

Keywords: compressive strength of column, carbon fiber wrap, glass fiber wrap.

1. Background

Reinforced concrete structure buildings that change function into buildings that require greater strength / capacity than the building's previous function, or those buildings have experienced a decrease in capacity but the building is still used to support its original capacity, the building should be strengthened.

The solution made for modification to the return / increase in strength of the planned structure is to rebuild or strengthen the structure. The choice to rebuild gives a lot of harm especially to costs, time and the environment, and certainly the choice to strengthen the structure is a wise choice.

One type of failure that often occurs in reinforced concrete structures such as structural columns of the building is a result of changes in building function or an increase in the load on the structure or due to a decrease in building capacity is a failure on compressive stress.

The compressive force is carried by column construction (Concrete and reinforcement), but because to add the area of the press so that it increases the ability of the structural column to withstand the compressive force, it is difficult to do the method by adding reinforcement to the outside of the column structure.

This reinforcement method uses Carbon Fiber Reinforced Polymers or more commonly referred to as CFRP, Glass Fiber Reinforced Polymers or often called GFRP. The use of CFRP and GFRP is a type of structure reinforcement by attaching CFRP and GFRP elements to the column structure which will be strengthened by using certain types of adhesives such as Sika Dur 330.

This study will compare the compressive strength of columns that do not use CFRP and GFRP and those that use CFRP and GFRP with experiments in the laboratory. And the column model made in the experiment is to give a load of 80% of the plan load on the column that will cause cracks in the column.

This study also prepared a steel portal design for the test object mentioned above which can bear the load capacity obtained from the test object.

2. Formulation of the problem

This research was conducted because in the construction implementation, it is often done to increase the existing column cross-sectional capacity without adding the dimensional dimensions of the column cross section. Reinforced column models using carbon fiber and glass coated with existing columns are expected to increase the ability of concrete compressive strength through restraints provided by fiber wrapping, so as to formulate the following:

1. Effect of the behavior of square-section reinforced concrete columns compared to the addition of carbon and glass-based carbon fiber to axial loading?

2. Effect of axial load capacity that can be held by the column after reinforcement with the addition of carbon fiber and glass based carbon fiber?
3. Effect of carbon and glass based carbon fiber additions according to standards

3. Research Objectives

1. Conducting the design and manufacture of steel portals as test sites for the concrete compressive strength of test objects.
2. Conducting compressive strength on column test items with concrete quality K-225 plan, as many as 6 (six) pieces, each 2 (two) pieces for unreinforced columns, columns reinforced with carbon fiber wrap and glass fiber wrap.
3. 3. Obtain an image of square section reinforced concrete column compressive strength compared to the addition of carbon and glass based carbon fiber to axial loading.
4. Perform analytical calculations of square-section reinforced concrete columns and with the addition of carbon and glass-based carbon fiber.
5. Obtain a picture of a square-section reinforced concrete column collapse model compared to the addition of carbon and glass-based carbon fiber to axial loading.
6. Comparing the capacity of square-section reinforced concrete columns compared with the addition of carbon and glass-based carbon fiber to axial loading.
7. Comparing the strain that occurs in square-section reinforced concrete columns compared to the addition of carbon and glass-based carbon fiber

4. Limitation of Problems

In order for this research to be focused and not wide-spread, it is necessary to limit the problem.

The limitations of the problem in this research are:

a. Determining the dimensions of the H-250 Steel that is formed can bear the maximum load of the test object.
b. The columns used are included in the short column classification.
c. The planned concrete quality is 19 MPa.
d. Concrete test specimens measuring 1580 mm in height and cross section dimensions measuring 120 mm x 120 mm, a number of 6 samples for testing compressive strength with reinforcement of Carbon and Glass type FRP respectively 2 samples and 2 reinforced concrete samples. Standard Size of Cylinder Concrete 15 x 30 cm.
e. FRP layer overlap thickness is 50 mm.

f. Strengthening with FRP is carried out in 1 layer.
g. The test load is an axial load.

5. Research methods

The research method is as follows:

a. Literature study as a theoretical study relating to the subject of research is through international and national reference books and journals.
b. Experimental studies namely the manufacture and testing of specimens for this study were carried out at the Laboratory of the University of North Sumatra, Medan.
c. Discussion of test results, data preparation and consultation with the supervisor.

6. Laboratory Testing

6.1 Preparation of Test Materials

The test materials were prepared and calculated in advance and analysed, it was then made into six (6) test specimens as shown in Figure 1, using Test Material I, Test Material II, Test Material III, Test Material IV, Test Material V, and Test Material VI as shown below.

Fig.1 Test Specimens

6.2 Testing of Specimens

Specimens were tested in the H-250 Steel that is formed can bear the maximum load of the test object. as shown in Figure 2, using Test Material I, Test Material II, Test Material III, Test Material IV, Test Material V, and Test Material VI as shown below.

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Fig. 2 Specimens were tested in H-250 Portal

7. The Result of Laboratory Testing

The maximum load that occurs in loading shows the addition of compressive strength in the column due to the restraints provided by adding a layer to the plain column, either by using carbon fiber wrap or from glass, as shown in Figure 3 below,

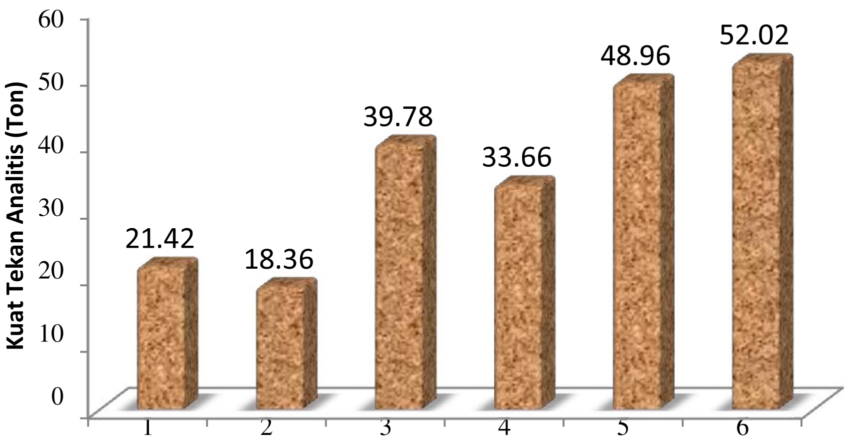

Fig 3. Result of six specimens axial Test

The load shown in Figure 4 below, Test Object I and Test Object II shows the least strain compared to Test Object III, Test object IV, Test object V and Test Object VI.

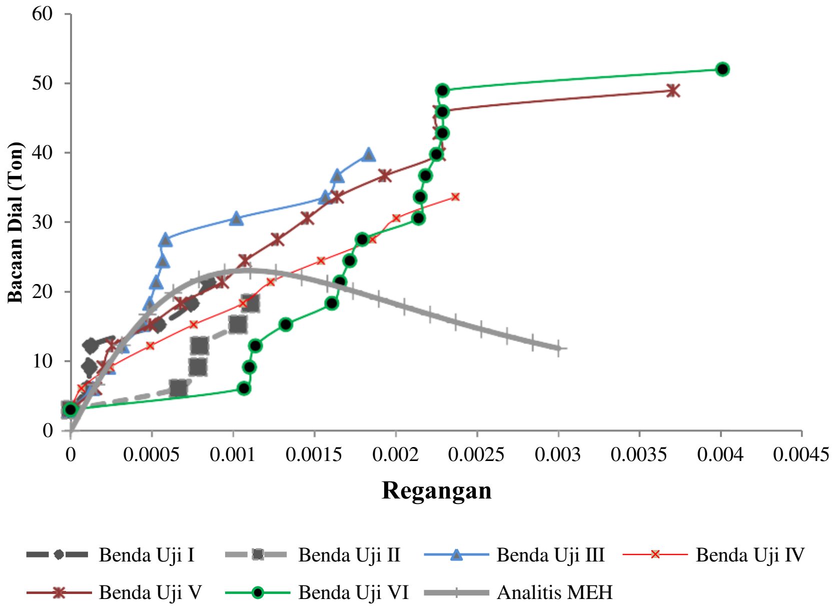

Fig 4. Test Object Load – Strain

Tests carried out on the six test objects show that the addition of bridle with fiber wrap that uses carbon and glass materials can increase or increase the compressive strength of the concrete in carrying the load.

8. Conclusions

1. The maximum load of the test portal that has been designed is 73.95 tons.
2. Test object I, reinforced concrete column with quality K 225 or f'c = 19 MPa, experiencing collapse at a compressive strength of 140 kg / cm2 or at a load of 21.42 tons, with a strain that occurs 0.85 $^{0}/_{00}$.
3. Test object II, reinforced concrete column quality K 225 or f'c = 19 MPa, experiencing collapse at a compressive strength of 120 kg / cm2 or at a load of 18.36 tons, with strain occurring 1.1 $^{0}/_{00}$.
4. Test object III, reinforced concrete column quality K 225 or f'c = 19 MPa, strengthened using Carbon Fiber Wrap 1 (one) thick layer 0.129 mm experienced a collapse at compressive strength reading 260 kg / cm2 or at a load of 39.78 Tons, with strain that occurs 1.8 $^{0}/_{00}$.
5. Test object IV, reinforced concrete column quality K 225 or f'c = 19 MPa, strengthened by using Carbon Fiber Wrap 1 (one) layer with a thickness of 0.129 mm experienced collapse at compressive strength reading 220 kg / cm2 or at a load of 33, 66 Ton, with strain that occurs 2.37 $^{0}/_{00}$.

6. Test object V, reinforced concrete column quality K 225 or f'c = 19 MPa, reinforced by using Glass Fiber Wrap 2 (two) layers with 2.6 mm thick experienced collapse at compressive strength reading 320 kg / cm2 or at load 48.96 Tons, with strain that occurs 2.27 $^{0}/_{00}$.
7. Test object VI, reinforced concrete column quality K 225 or f'c = 19 MPa, strengthened by using Glass Fiber Wrap 2 (two) layers with 2.6 mm thick experienced collapse at compressive strength reading 340 kg / cm2 or at load 52.02 Tons, with strain that occurs 2.29 $^{0}/_{00}$.
8. This study shows an increase from 19.89 tons to 36.72 tons or an increase of 184% for CFRP and an increase from 19.89 tons to 52.02 tons or a 253% increase for the use of GFRP.
9. Fiber wrap type of carbon has a greater elasticity than glass type fiber wrap.

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