

Analysis of Reinforcement Overlapping on Retrofit Reinforced Concrete Beams of Bending Behavior

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Analysis of Reinforcement Overlapping on Retrofit Reinforced Concrete Beams of Bending Behavior

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Abstract. The length of reinforced concrete blocks varies widely, while in general the reinforcement produced in Indonesia is 12 m. Therefore, the use of reinforcement in a long stretch is done to be connected. The through connection is the most economical connection^[2]. Lap splice can be made by overlapping the reinforcement which is touching or separate^[3]. Splicing reinforcement can cause the strength of reinforced concrete beams to be reduced or even damaged so that rehabilitation measures are needed which can be in the form of retrofit (repair). Retrofitting with wiremesh and self compacting concrete (SCC) is considered to improve building structures. Reinforcement overlapping on reinforced concrete beams retrofit with wiremesh and self compacting concrete can be analyzed by numerical methods to determine their effect on bending behavior. Now, to analyze a structural behavior, it can be done using finite element method based program. The application of the finite element method is used in several programs, including ABAQUS, ADINA, Atena, ANSYS, etc. This study aims to analyze the overlapping of reinforcement in retrofit reinforced concrete beams against the flexural behavior, overlapping is made at one-third and one-third of the beam span using finite element method based analysis software.

1. Introduction

The length of reinforced concrete blocks varies widely, while in general, the reinforcement produced in Indonesia is 12 m. Therefore, the use of reinforcement in a long stretch is done to be connected. Reinforcement can be done in three ways, namely lap splices, welded splices, and mechanical connections [1]. The through connection is the most economical connection [2]. Lap splice can be made by overlapping the reinforcement which is touching or separate [3]¹. Splicing reinforcement can cause the strength of reinforced concrete beams to be reduced or even damaged so that rehabilitation measures are needed which can be in the form of retrofit (repair). Retrofitting with wiremesh and self-compacting concrete (SCC) is considered to improve building structures. Reinforcement overlapping on reinforced concrete beams retrofit with wiremesh and self-compacting concrete can be analyzed by numerical methods to determine their effect on bending behavior. In the analysis of a problem that is approached using numerical methods, it generally involves large numbers of numbers and a fairly complicated mathematical calculation process [4].



Manual calculations can be time-consuming and consuming time, but with the advent of various computer software, this problem can be solved easily. Now, to analyze a structural behavior, it can be done using a finite element method based program. In civil engineering, the application of the finite element method is used in several programs, including ABAQUS, ADINA, Athens, ANSYS, etc. Analysis using the program can save time and money for physical modeling. This is because, there is no need to assemble specimens, no need to wait for the age of the concrete to be ready for testing, no need to install a strain gauge, and no need to install machines. In addition, numerical tests can produce results that are not obtained from experimental tests, including stress and strain at each step of the analysis. Based on this explanation, a numerical analysis was carried out to determine the bending behavior caused by the overlapping of reinforcement in retrofit reinforced concrete beams, overlapping reinforcement was made at one half and one-third of the beam stretch.

2. Methodology

2.1. Overview

The finite element method (FEM) is a numerical method that can be used to solve structural, thermal, and electromagnetic problems. In this method, all complex problems such as variations in shape, boundary conditions, and loads are solved by the approach method. Because of its diversity and flexibility as an analytical tool. The most basic concept of the finite element method is solving a problem by dividing the object of analysis into finite pieces. These small pieces are then analyzed and the results are combined back to find a solution for the whole area. The word "finite or finite" is used to emphasize that the small parts are infinite, as is commonly used in the analytical integral method. Dividing the analysis part into small parts is called "discretizing or discretization". These small parts are called elements, which are composed of corner points (called nodes, or nodes) and the area of the element formed from them. Physically dividing an object into smaller parts actually leads to the creation of differential equations. So more mathematically, FEM is defined as a numerical technique for solving problems expressed in differential equations. However, usually, the mathematical definition of FEM gives a complicated impression.

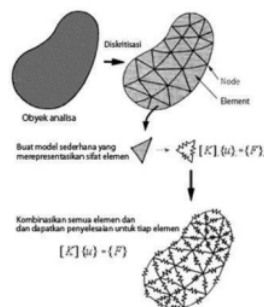


Figure 1. Basic concepts of FEM

2.2. Element Model

Solid continuum C3D8R was used for concrete and ECC as a form of the eight-nodal liner brick element. This element consists of three degrees of freedom in each node in the form of translational movement U1, U2, and U3 (see Figure 2(a)). As shown in Figure 2(b), a two-node truss element (T3DR) with 3D analysis was used to define the element of reinforcing steel in which this element was homogenized over the concrete. In T3D2, the two-node depicts two degrees of freedom consisting of compression and tension which the flexural moment is hence neglected [5].

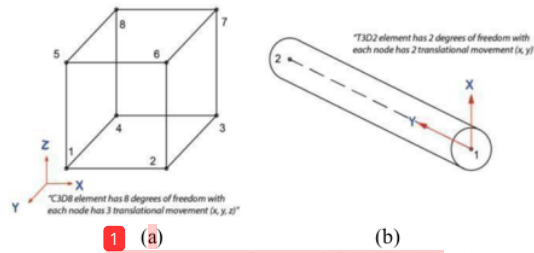


Figure 2. Element types of FE model (a) C3D8R; (b) T3D2

2.3. Variation of Testing Objects

The research method used in this research is numerical analysis. The dimensions of the specimens are 20 cm high, 15 cm wide and 270 cm long and the beam reinforcement was analyzed using the finite element method.

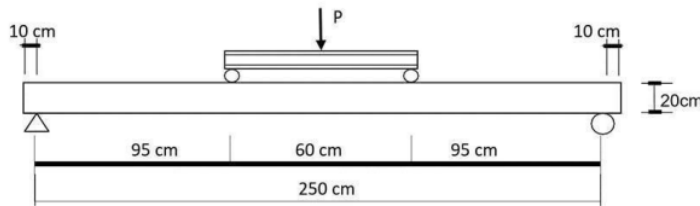


Figure 3. Design of Beam and Load

Overlapping reinforced concrete beams are placed in one-half and one-third of beam stretch with a variation of the splices length.

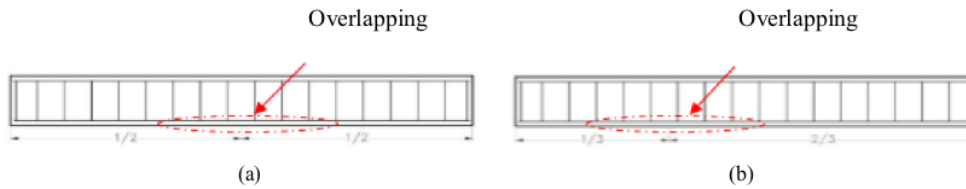


Figure 4. (a) one-half of beam; (b) one-third of beam

Variations in the length of joints in reinforced concrete beams reinforced with wiremesh and self compacting concrete (SCC) are made of 1 types at one-half of the span and 1 type at one-third of the span. Variations in the length of the joint are 50d. The wiremesh reinforced beam and SCC panels are referred to as BWS and normal beams are referred to as BN. The design drawing of each test object can be seen as follows:

Table 1. Variation of Testing Objects

Type	Overlapping Position	
	Splices	Splices
BN	-	-

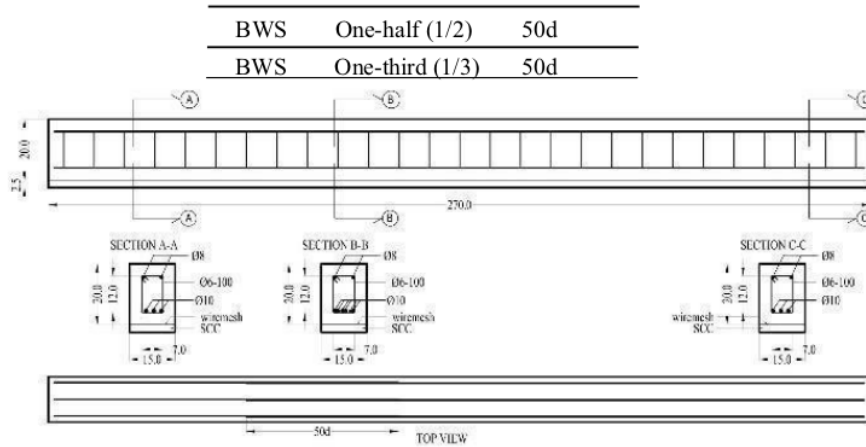
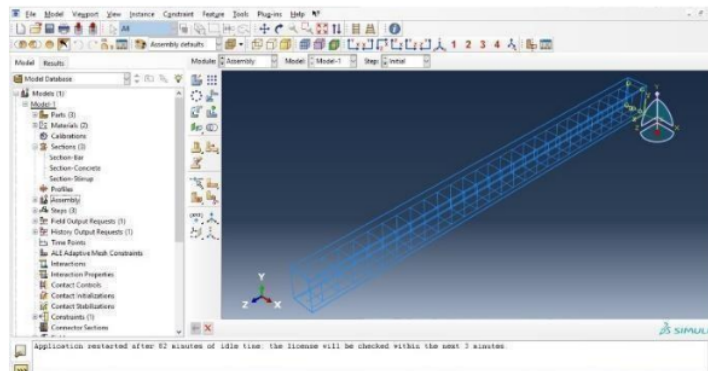


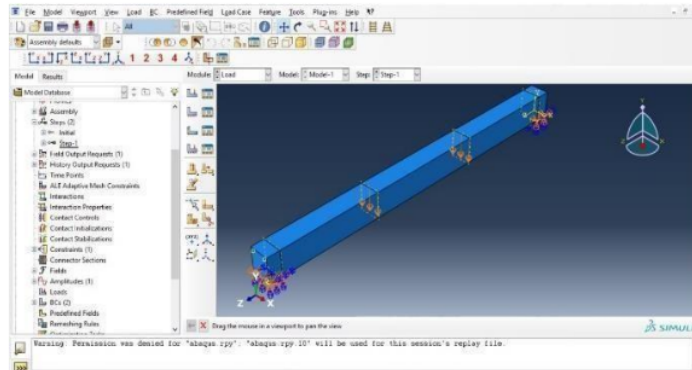
Figure 5. BWS one-half (1/2) 50d

2.4. Modeling Using Software

Inline, to be able to obtain numerical analysis results from FEA-based software, it uses several steps, namely making parts, input properties, selecting elements (assembly), determining interactions, providing support and load, and running. After the running process is complete, the analysis results will be displayed.



(a)



(b)

Figure 6. (a) assembly process (b) process of providing support and loads

3. Results and Discussion

3.1. Correlation of Load and Deflection BN

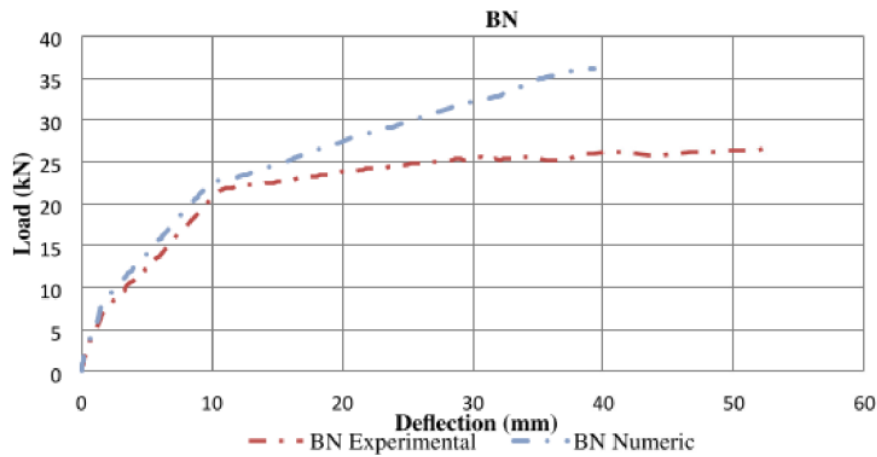


Figure 7. Graph of Load and Deflection BN

From the graph above shows that the deflection that occurs in normal concrete from the numerical test results is higher than the results from the experimental test. And the load that is held by the beam in the numerical test is higher than in the experimental test. The crack and melting points in experimental and numerical tests were almost the same.

3.2. Correlation of Load and Deflection BWS 1/2

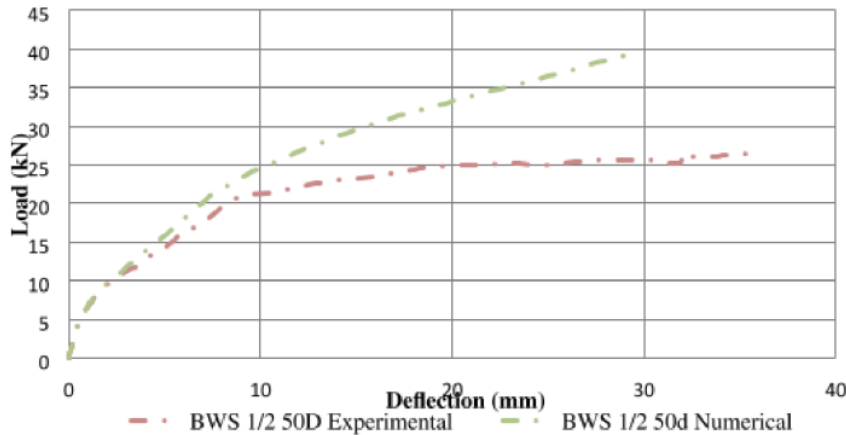


Figure 8. Graph of Load and Deflection BWS 1/2 50d

From the graph above shows that the deflection that occurs in BWS 1/2 50d from the numerical test results is higher than the results from the experimental test. And the load that is held by the beam in the numerical test is higher than in the experimental test. The crack points in experimental and numerical tests were almost the same.

3.3. Correlation of Load and Deflection BWS 1/3

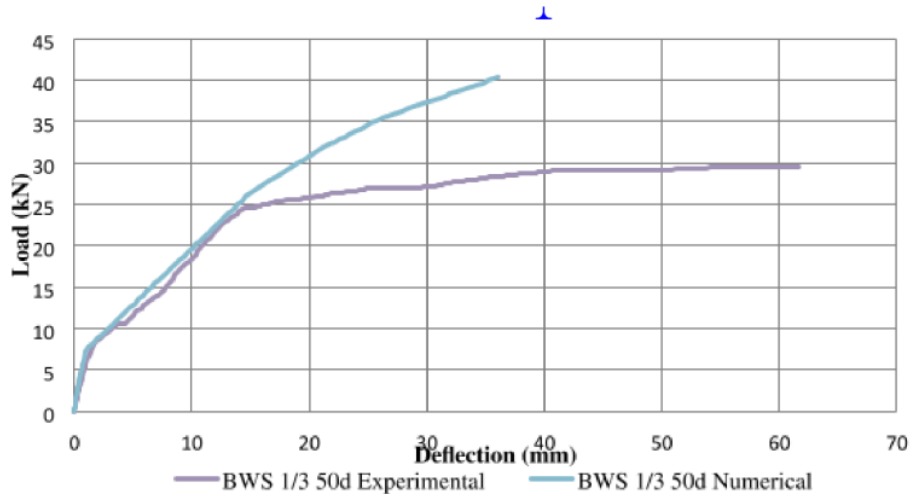


Figure 9. Graph of Load and Deflection BWS 1/2 50d

Based on the graph, it can be seen that the experimental and numerical test results are almost the same until the yield position but start to differ afterwards. In numerical testers, concrete is stronger withstand loads where as in experimental tests, beams withstand a much smaller load.

4. Conclusions

From the results of research and discussion, several conclusions can be drawn as follows Numerical testing shows that based on the finite element method, concrete can withstand more loads than the numerically tested concrete. The initial test until yield, the results of the numerical and experimental tests are almost the same and begin to experience significant differences after the reinforcement is yielded

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8
