Analysis on the value of stiffness of the dual joint straightness notch joint of beams due to cyclic lateral load

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Analysis on the value of stiffness of the dual joint straightness notch joint of beams due to cyclic lateral load

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Abstract. Precast concrete is an answer to the demands of building structures that save time, but cannot be used widely because of the reliability of the connection, especially during an earthquake, the desired earthquake-resistant building structure must have sufficient strength and rigidity. Stiffness is one of the factors that determine the response of a structure to earthquake loads. When connected with earthquake loads, a structure must have sufficient rigidity so that its movement during an earthquake can be limited. This study aims to determine and analyze the stiffness in the double columns straight joint beam notches due to lateral cyclic load. By dividing 3 (three) types of test specimens, namely Monolithic Column Beam, Type 1 Column Joint (SBK), and Type 2 Column Beam Joint (SBK). The connection used is a double straight notch and using the grouting method. Testing and analysis using the Displacement Control Method with the European Convention for Constructional Steelwork (ECCS) 1986 standards. The results showed the monolith column (BK) specimens have a greater stiffness value compared to SBK 1 specimens and SBK 2 specimens.

1. Introduction

Connection problems are the main problems faced in precast concrete planning. Joints are a very important element in the design of earthquake resistant building construction. Collapse of buildings due to earthquake is determined by the quality of the connection. In order for a building to perform well when receiving earthquake loads, it must meet the beam-column connection requirements. On structure, stiffness is one of the factors that determine the response of a structure to earthquake loads. When connected with earthquake loads, a structure must have sufficient rigidity so that its movement during an earthquake can be limited. The smaller the structural deviation, the more rigidthe building.

Paulay, T & Priestley, M.J.N [1] explain that the beam-column joint is a critical area that can respond inelastically to withstand an earthquake. The joint will work as a horizontal and vertical shear force and has the value of several adjacent beams and columns. Widodo [2] Joint beam-column in a static structure does not necessarily play an important role in the restraint so that there is no freedom of rotation in the beam. Restriction occurs when the beam- column joint is a monolithic and rigid whole. Joint stiffness is needed so that the unbalance moment redistribution instructure analysis canbe done.

To find out the connection behavior, it needs to be studied further. The way to learn it can be by experimental test or by numerical test with the program. The experimental test is a test that is carried out with a physical model made in the laboratory, while the numerical test analysis is a method of solving mathematically formulated. Technological developments encourage the progress of the program. Therefore numerical testing with programs is increasingly required to perform calculations that cannot be completed by hand. To analyze a structural behavior, it can be done using finite element based program "finite element method". In civil engineering, the application of the finite element method is used in several programs, In this case Abaqus application is used.

According to [3] the numerical analysis obtained is generally close to experimental results, although not fully verifiable against experimental results. From the results of research by [4-6] the results of specimen testing carried out experimentally in the laboratory compared to numerical analysis using software are not much different, including stress-strain graph data obtained from experimental results and numerical analysis.

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2. Methodology

2.1. The Finite Element Method (FEM)
In this study, 3 types of models were analyzed using the Abaqus 6.14 application, 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, this method has received attention in the world of engineering.

2.1.1. Modeling
The use of the software was initiated by entering the image design in the module part according to the image specifications

2.1.2. Properties
Then proceed by entering material parameters in the form of concrete and steel on the properties menu.

2.1.3. Assembly
At this stage the individual parts that have their respective coordinate systems are combined into one unit model.

2.1.4. Step
The step setting function is useful for determining the solution at each step or stage of loading. At each step that is made, further parameters can be determined such as boundary conditions and loading.

2.1.5. Interaction
The interaction module is used to determine the contact area or type of interaction experienced by the model. Interaction Determination is a facility that provides a relationship between parts in an assembly. In this example of modeling a reinforced concrete column beam structure, the relationship between concrete and reinforcement is connected as an interaction between the embedded region.

2.1.6. Load
The load module serves to define the support and load that occurs on the test object.

2.1.7. Mesh
This mesh is used to control the making of the mesh on the model. The number of nodes and elements can be controlled with the mesh control, including the shape of the mesh elements and how to place the number of nodes. Mesh plays a very important role in determining the accuracy of analysis and simulation, because the number or nodes used in the model will affect the accuracy of the simulation results.

2.1.8. Running

Job serves to perform the running process on the model we have created. Once the program we entered is completed we submit it to the job module to perform the completion process numerically

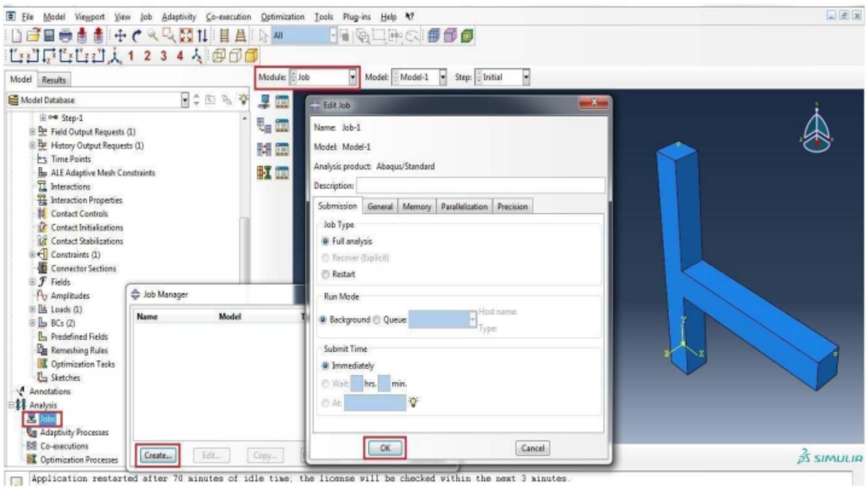

Figure 1. Running Sample

2.2. Test Object Design

The making of these test specimens consisted of 2 pieces, 1 for monolith connections as shown in figure 1 and 2 for precast connections as shown in Figure 3.

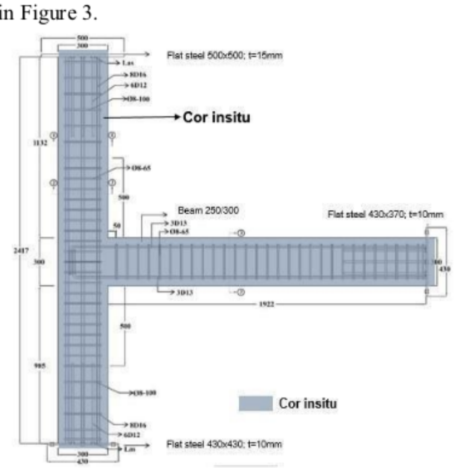

Figure 2. Monolith

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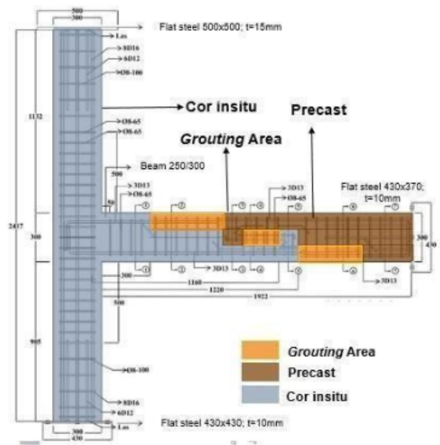

Figure 3. Double notch connection beam-column joint type 1 (SBK 1)

2.3. Analysis Method

Rigidity for structure is important. Stiffness restrictions are useful for maintaining construction so as not to deflate more than the deflection required. Stiffness is defined as the force required to obtain a displacement unit. Stiffness value is the slope angle of the relationship between load and deflection. The more rigid a structure, the greater the value of its stiffness.Stiffness is the force required to produce a unit displacement. Whereas, Flexibility is a displacement generated bythe unit force as shown in Figure 4.

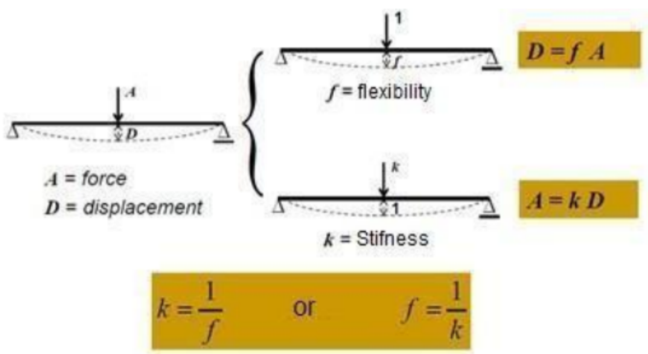

Figure 4. Stiffness

Stiffness is a measure of the voltage needed to change the unit of shape of a material. The magnitude of the stiffness of a material is its modulus of elasticity, which is obtained by dividing the unit stressreceived by the material by changing the unit shape of the material.

$$K = P / \delta$$

Where :
K is Stiffness
P is Load δ is
Deflection

According to SNI 03-2847-2013, the moment of inertia for planning concrete beams using effective inertia (Ie), where the value is between Ig and Icr.

3. Results and Discussion

3.1. Comparison of Stiffness of Components of Monolithic, SBK Components

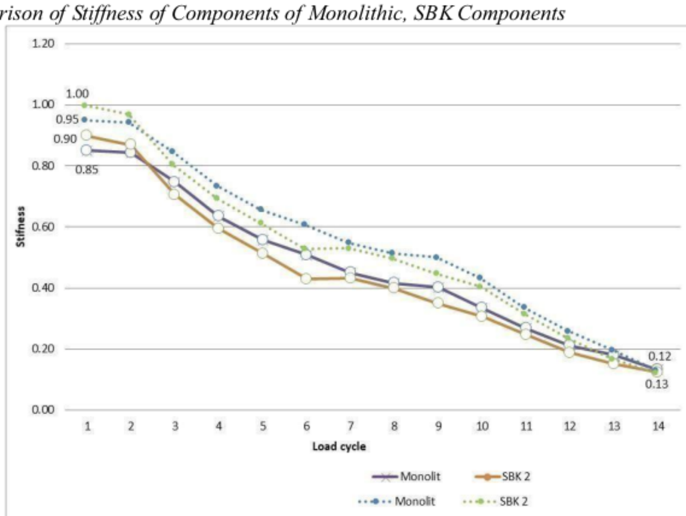

Figure 5. Comparison of the rigidity of the test object thrust direction of monolith, SBK Stiffness degradation is the process of progressively losing structural stiffness due to a history of loading.

The stiffness of the specimen at each loading cycle for the thrust direction is shown in Figure 5 In the Experimental Test at the beginning of the loading cycle is not constant. Whereas in the numerical test, the stiffness degradation occurs constantly. In addition, the degradation of the numerical test stiffness is smaller than the experimental test. Both of these indicate a numerical test resulting in a stable joint strength over the load cycle.

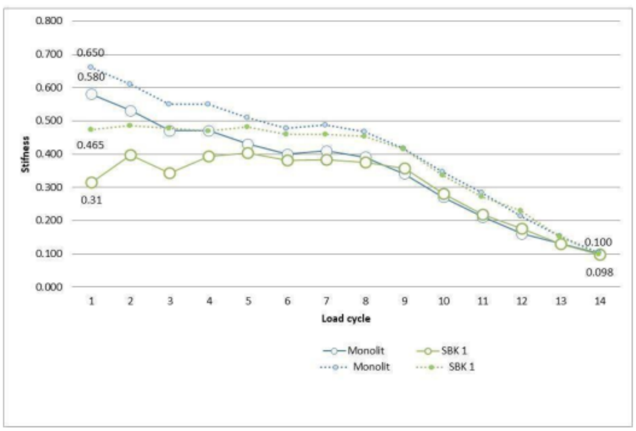

Figure 6. Comparison of the tensile stiffness of the Experimental Test with the Numerical Test

Meanwhile, the stiffness degradation for the tensile direction for the experimental test shows a constant degradation when compared to the thrust condition.

The initial stiffness of the joint of the two numerical results is very large compared to the experimental test results. However, the final stiffness of the connection between the two numerical results models is the same as the experimental test results.

4. Conclusions

It can be seen from the experimental and the finite element method using **Abaqus** that the initial stiffness of the monolith beam-column component in the direction of thrust is greater than the initial stiffness of the SBK components. For tensile conditions, the stiffness of the Monolith specimen beam column component in the tensile direction is greater than the initial stiffness of the SBK. From the study results, the numerical test results showed that there was not much difference in connection behavior with the experimental test results

References

[1] Paulay T & Priestley M J N 1992 Seismic Design of Reinforced Concrete and Masonry Buildings(Christchurch and San Deigo: John Wiley & Sons, Inc.)

[2] Widodo S & Priyono N M S 2007 Perancangan Gedung Sekolah Tahan Gempa Di CabangMuhammadiyah Wedi Klaten. Surakarta: Universitas Muhammadiyah Surakarta.

[3] Rudi Y, Ilham A, Nurhuda, Sukamta, and Fitriani I 2014 Perilaku dan Kekuatan SambunganKolom pada Sistem Beton Pracetak. Jurnal MKTS Jurnal Ilmu dan Terapan Bidang Teknik Sipil 20

[5] Ricko A M, Sudirman, Herman P, Irmawaty A 2010 Study on Behaviour of Precast Beam Colomn Joint Using Steel Plate Connection (JPSP). Proceeding of First Makassar Internasional Confrence on Civil engineering March 2010

[6] Novalinus B 2017 Study of the beam colomn joint on coach model connection as the result of syclic lateral loading to the stiff ness value Universitas Hasanuddin Teknik Sipil, 8

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