STUDY OF SHEAR BOLT CONNECTOR STRENGTH TEST ON LIGHTWEIGHT CONCRETE COMPOSITE PANEL FEROFOAM TOWARDS PURE SHEAR USING PUSH OUT TEST METHOD

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ABSTRACT

The use of shear connectors in composite structural element is very important that a structure composite elements can work as a single unit in a resist shear forces. This study aims to examine the large load capacity and slip bolt shear connectors used in lightweight concrete composite panel ferofoam. Pure shear tests on shear connectors performed using the push-out test. Parameter variations speciefic testing is only on gravity of lightweight concrete foam. Shear connector is in the form of normal strength bolt, fu = 340 MPa diameter Ø10 mm are tied with the nut on ferofoam panel of 40 mm thickness, and 50 mm long embedded in lightweight concrete slab foam specimen push out. Cement Water Factor (CWF) ferofoam panels and lightweight concrete slab foam specimen push out is 0.4. Lightweight foam concrete ferofoam panel SG is 1.6 (f'c = 20 MPa) and the lightweight concrete slab foam push-out specimen is used variations of SG 1.0 (f'c = 5 MPa), 1.2 (f'c = 10 MPa) and 1.4 (f'c = 12 MPa). In ferofoam panel is used reinforcement D13 mm as forming the framework of the panel with wiremesh layer as much as 4 layers. Specimens push out amount 3 pieces each SG with a total of 9 specimens. To control the compressive strength of lightweight foam concrete ferofoam panel and lightweight push-out concrete slab foam specimen is made 12 of 15 x 30 cm cylindrical specimens. The average experimental results of shear connectors bolts capacity on lightweight concrete foam of push out research SG 1.0; 1,2 and 1,4 respectively is 9.03 KN, 11.68 KN and 13.49 KN with a slip of 3.57 cm, 2.74 cm and 2.00 cm. Destruction on every variation of SG specimens represent a failure on the front bearing shear bolt connector on lightweight foam concrete slab push out specimen.

Keywords: push out test method, composite structure, lightweight concrete composite panel ferofoam

I. INTRODUCTION

Lightweight foam concrete as a structural element application that uses ferofoam also been carried out as in the floor plate precast concrete composite panel ferofoam. Plat light is a combination of two layers of lightweight foam concrete slab that plate ferofoam panels and lightweight concrete slab foam filler which has a specific gravity light from the plate ferofoam casted on the upper surface of the precast ferofoam plate. Precast ferofoam concrete lining panels are not monolithic with lightweight foam concrete on top of it raises the issue of the slip and uplift (lift) in the contact area between the concrete elements when a shear force

works when the plate structure to bear the burden. This composite conditions make the need for an interface on a plate sliding panel ferofoam the foam lightweight concrete composite. Shear connector is a mechanical tool dial that serves to resist horizontal shear that occurs during loading and preventing slip a value shift which occurs on the surface of the two types of components of the composite material. Therefore, the use of shear connector in a composite structural element is important. Before the use of shear connector, it is necessary to do observations regarding the contribution of shear connectors in resisting the shear forces are used in a composite element as in the lightweight concrete composite panel ferofoam.

The purpose of this study was to examine the load capacity and large slip that occurs in the bolts shear connectors used in lightweight concrete composite panel ferofoam to some variation of density with pure shear test. This research is expected to provide information on how much capacity is accepted by shear bolt connector and lightweight concrete foam, as well as behavior and destruction on lightweight concrete foam when done loading. The results are then compared with theoretical calculations related to the capacity of shear connectors ferofoam panel on the lightweight concrete composite foam. In addition, this research is also expected to add to the repertoire of science in civil engineering for practitioners and researchers in the field of civil engineering, especially regarding the use of shear bolts connecting the lightweight foam concrete composite elements.

This research was conducted at the Laboratory of Construction and Building Materials Technical University of Syiah Kuala, Darussalam, Banda Aceh. The test on pure shear tests on bolt shear connectors is push out test. Shear connectors are black bolt (bolt normal quality, fu = 340 MPa) Ø 10 mm diameter are tied with the nut on the panel ferofoam 40 mm thick and 50 mm long embedded in lightweight foam concrete of specimen push out test. The use of shear connectors for connecting the bolt shear is a type of shear connectors that allow it to be installed and used on the panels lightweight foam concrete composite elements. Cement Water Factor (CWF) used in the variation of density differences in lightweight foam concrete composite elements of push out test specimen was 0.4. Density of lightweight foam concrete panels each ferofoam planned (Speciefic Gravity) SG 1.6 (f'c = 20 MPa). On lightweight foam concrete composite of push out test specimen is used variation of SG 1.0 (f'c = 5 MPa), SG 1.2 (f'c = 10 MPa) and SG 1.4 (f'c = 12 MPa). Push out specimen is 2 pieces shape with 300 x 450 x 10 mm size is located between the panel's side that have been installed ferofoam shear connectors. The push out test object is numbered 9 specimens with each variation in specimen plate SG object push out test is numbered three (3) specimens. On the ferofoam panel specimen push out test objects is used reinforcement Ø 13 mm as forming the framework of the canal with wiremesh layer as much as 4 layers. The use of reinforcement D13 coated wiremesh follows the shape of the component elements of precast floor plate ferofoam concrete composite lightweight foam that already exists today, in which the plate is made into a composite structure with a layer of lightweight foam concrete. To control the compressive strength of lightweight foam concrete ferofoam panels and lightweight concrete slab foam push-out specimen is made 12 15 x 30 cm cylindrical specimens. Results of push out research on each lightweight foam concrete SG showed that the capacity of shear connectors bolt is experimentally bigger than theoretically. The destruction that occurs in test specimen on every variation of SG specimen is bearing failure on concrete located in front of concrete bolt shear connector on lightweight foam concrete push out specimen. The failure

causes bent on bolt shear connectors, because in this condition the load is on hold by the head of shear connector embedded at a 5 cm depth into the lightweight concrete slab foam specimen push out. This makes the maximum load reached at slip a great value as well.

II. LITERATURE REVIEW

Theories that support the issue will be presented that some of them quoted from the finding that has relevance to the study, the journal and the opinion of the experts as well as from existing references.

2.1. Lightweight Concrete Concepts

Indonesian National Standard (SNI) imposes the limit of lightweight concrete criterion is the density of <1900 kg / m3. There are several methods that can be used to reduce the density of concrete or made concrete lighter as follows (Neville, 1999: 688):

a. Make bubbles of gas/air in the mortar, causing a lot of air pores in the concrete;
b. Using lightweight aggregate, such as baked clay, pumice or artificial aggregates so the concrete that has produced will be lighter than regular concrete;
c. Make concrete without using grains of fine aggregate or sand referred to as non sand concrete.

2.2. Lightweight Concrete Foam Ferosemen (ferofoam)

Ferofoam is another variant of ferosemen. The difference lies in the mortar filler. According to (Naaman, 2000: 9) quoted from ACI Committee 549 (1999: 2), ferosemen is a kind of thin reinforced concrete comprising hydraulic cement mortar with a relatively small wire network composed of several layers. In general arrangement consisting of a mortar ferosemen structure, wiring, and a reinforcement frame (Djausal, 2004: 12). Unlike the ferosemen, ferofoam mortar formed of lightweight concrete foam is a mixture of water, cement and foam. The foam itself is the result of a constituent, namely foam generator. There are currently various studies ferofoam panel plate that have been done. One research about panel ferofoam which one of them by Effendi (2013) is a U profiles precast floor plate by using steel bars and wiremesh wire as reinforcement using lightweight concrete foam.

2.3. Composite Structure

Composite structure is a combination of two kinds or more components of different materials or the same material but has a different quality and combined into a single component. In general, the composite consists of two components continuously by means of a dial. Composite is made with a view to gaining a better combined properties of the each constituent components (Moriscos, 1991). Composite action occurs when two loadbearing structural rods such as the concrete slab and the steel beam as a buffer connected thoroughly and deflection as a whole. Basically, the composite action on composite beams can be achieved or not, it depends on the shear connectors. To obtain a composite action shear

connector is needed to transfer the shear force of the concrete slab to the beam and defend the concrete slab from uplift force (vertical lift force). Generally, shear connectors placed on the upper wing steel profile. It aims to reduce the occurrence of slip on the concrete slab with beam steel. (Widiarsa and Deskarta, 2007).

2.4. Shear Connector

Shear connectors is a mechanical dial tool that serves as a retaining shear force and lift force arising at the contact area of the materials that make up the composite components (Suwandojo and Zubaidah, 1987). In generally, a capacity of a shear connector to be able to transfer the horizontal shear is affected by stiiffness and comprehensive contact area of the shear coonnector with the concrete. Factors that influence the occurrence of deformation in shear connectors, namely size, placement location, the location of maximum moment, and how to install. (Windiarsa and Deskarta, 2007). In the absence of shear connectors, slip will occur even at low voltage condition. (A. Nethercot, 2004). One example of composite construction using shear connectors are on a bridge girder, where the shear connectors are used to connect the bridge girder made of steel plate with the vehicle floor made of concrete.

2.5. Bolt Capability On Ferosemen

Failure bolt connection on ferosemen construction is indicated by the failure of the concrete material capability around the bolts. It is caused by a high voltage caused by the ignition between the bolt and the hole. According to Mansur Composite shear connectors is a combination of bending shear connectors with appendage shear connectors.

2.6. Push Out Test

In the early 1930s , the push -out test was used as a method for testing the capacity of shear connectors spiral . In further development , push out test testing used widely to learn about the other types of shear connectors . Although the conditions of stress that occurs not show voltage conditions that occur in the actual composite beam , push out test was used to determine the characteristics of the load and slip on static loading conditions (Natalino and Giuriani , 2001).

2.7. Slip

According to Sabnis (1979), which was quoted by Alfachrul (2008 : 30) , shear connectors which resilient when given an assessment as P , then the shear connectors will has the effect. The value of this influence is called slip . To prevent larger slip then shear connectors is installed . force P is assumed as the horizontal shear force to the actual construction . The capacity of shear connectors which can be held by each of shear connectors is equal to the load P which is divided with the number of shear connectors which used.

III. RESEARCH METHODS

In this method, it described the materials and equipment which used , the manufacturing process of the test specimen , test methods, and data analysis method that used . The following will describe one by one the methodology that used:

3.1. Making Process of Test Objects

The process of making the test object is performed in the laboratory include the preparation, planning, design, test object push out , reinforcing steel tensile test , wiremesh tensile test , and bolts . then, reinforcement assembly is done by means of welded made canals C -shaped , and the installation of the reinforcement wiremesh wire on ferofoam panel channels. And then plan lightweight foam concrete mix design for the canal ferofoam panel and BRB specimens push out the plate.

IV. TESTING METHODS

4.1. Compressive Strength of Concrete Testing

Press cylindrical test objects measuring with 15 cm diameter and 30 cm high . Tests carried out is using the loading test machine -made brands Ton Industrie Manhein Germany . the strength of concrete cylinders Testing shown in the following figure :

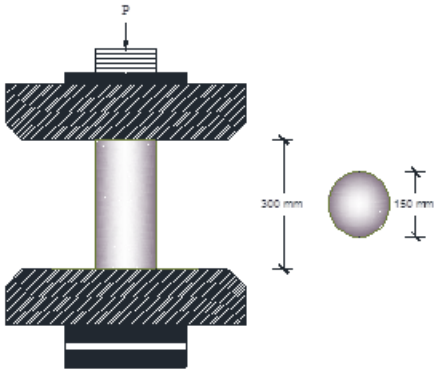

Figure 1 Cylinder Concrete Compressive Strength Testing

Imposition given until the test object is destroyed . The compressive strength of concrete Testing as the control of concrete quality on every mix design and plat panel ferofoam BRB specimen push out the test specimen plan.

4.2. Push Out Test Testing

Push out test Testing was performed to learn about the capacity , behavior and slip on shear connectors with pure shear tests which carried out to achieve the failure conditions of specimen or limited only for license capacity of the equipment test . generaly, the push out test testing was performed using specimens like two concrete plates which connected to each wing on a IWF steel beam using shear connectors . But in this specimens experiment, IWF

steel beam is replaced with a canal ferofoam panel which given a shear connectors in the form of bolt which mounted on canal ferofoam panel by binding with the nut. Before giving the load , the top of channel ferofoam panel which uneven is leveled using grinding and then on it steel plates is placed whichthe goal is for the given load is distributed evenly throughout the surface of the cross section of the canal ferofoam panel . On this push out test testing, work load is a load P which assumed as the horizontal shear force to the actual construction . Testing is done by giving the load on the specimen gradually and continuously . The reading of the data from the test is appears on the screen and recorded using Portable Data Logger TDS 302. The transducer mounted in a vertical direction parallel to the direction of loading . The transducer which used to measure the slip is a transducer type CDP- 100.

4.3. Data Analysis Methods Used

The data analysis is based on data which obtained from the results of the test specimen . that data is the data of tensile strength testing of reinforcing steel channel frame ferofoam panel , wiremesh tensile strength , bolts tensile , concrete cylinder compressive strength and capacity and shear connectors slip of bolt on push out test testing. The results of tensile strength of the reinforcing steel frame panel and wiremesh shown as the information data from materials strong used on the canal ferofoam panel . For concrete quality, it is obtained from an average compressive strength of concrete cylinder of test specimens for each casting channel ferofoam panel and the plate BRB specimens push out. The data that obtained from the push out testing that consists of load data, and the amount of slip that occurs in bolts shear to the concrete lightweight foam with some variation SG 1.0 ; 1.2 ; and 1.4 . Data were calculated using Microsoft Excel Software . Data processing is done after all the testing of the specimen is completed .

V. FINDINGS AND DISCUSSION

The Results that obtained from this research include the composition of the concrete mix , the tensile strength and wiremesh reinforcement panel testing, tensile strength bolts testing, cylinder concrete compressive strength testing , and capacity of shear connectors screws on the ferofoam panel lightweight concrete composite foam testing with method push out test testing.

5.1. The Results of making The Test specimen

The process of making the test specimen implemented in accordance with the research methods that used . The test specimen thart made is a specimen of lightweight foam concrete cylinder to control compressive strength and also test specimen push out.

5.2. The Results of compressive strength testing of concrete cylinders

Testing the compressive strength of the cylinder concrete measuring 15 x 30 cm performed on 12 pieces of specimens where on the concrete casting ferofoam panel SG 1.6

consists 3 specimens on the cylinder plate and BRB specimens push out also consists 3 specimens in each SG 1 , 0 ; 1.2 and 1.4.

5.3. The test results of push out test

Capacity shear bolts connectors Testing on the lightweight foam concrete is done by push out test method. Results that obtained in the form of capacity value and slip on bolt shear connectors used on ferofoam composite panels specimens with lightweight concrete foam on variation SG 1.0 ; 1.2 and 1.4 . Expenses are taken is 80 % of the maximum push out compressive load and on the maximum slip condition which can be held by a bolt shear connectors on the push- out specimens . In this specimen there are two (2) pieces of bolts as shear connectors on each specimen , so that the load can be held by each of shear connectors is a burden that has been divided in two.

VI. DISCUSSION

The discussion presented the results which obtained from each push out test specimen with the SG variations on a BRB plate push out specimens. The discussion of push out itself is emphasis on the magnitude of load capacity which acceptable by the shear connectors and the maximum slip that occurs on the surface of ferofoam with lightweight foam concrete which is connected by bolts as the shear connectors. The results of the testing is also compared with the theoretical analysis results of shear connectors capacity calculation . To get better results to research a kind of in the discussions and discussion result research, submitted a few of the author as follows:

1. Do research advanced in liaison sliding bolt with employing variations sg and fc different on the license plate light concrete foam specimens push out.
2. Make research with the use variation diameter liaison sliding bolt different on each sg plate specimens push out.
3. Do research advanced in liaison sliding bolt by using light concrete foam fibrous on the license plate specimens push out.

VII. CONCLUSION

Conclusion that can be taken from a research has done as follows:

1. Bigger sg and fc on light concrete foam bigger capacity the detained by liaison sliding bolt and the small value slip what happened to liaison sliding. So does the contrary.
2. There are two the maximum detained by liaison sliding bolt when before there is a failure bearing on the license plate specimens push out and when failure specimens when the weight largest reached at slip maximum.

3. Large in capacity liaison sliding bolt on the concrete light foam specimens push out sg 1.0; 1.20 and 1.4 respectively is 9,03 kn, 11,68 kn and 13,49 kn. Value slip maximum occurring in liaison sliding bolt with long 5 cm on the concrete light foam specimens push out sg 1.0; 1.2; and 1.4 respectively is 3,57 cm, 2,74 cm, and 2.00 cm.

4. Connecting sliding bolt can be used on light concrete foam because burden can be held for even though i was there is a failure bearing on the concrete light foam.

5. Aceh belonging to the region with levels of risk earthquake a high .The structure of the building planned in aceh must have to security earthquake. Burden earthquake is burden received a building is the impact of movements of the ground. Election material mild in building vertical upward such as a building is advisable to reduce mass of the building. It cannot be denied walls and plates the floor have a role in deliver a load on the building of the, therefore material the wall usually used in the development of buildings in material a material that has been discussed and researched above it could add diversity science in the construction field and building materials.

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