Flexural strength of precast reinforced concrete beam extension

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Abstract. This paper presents the performance analysis of the precast reinforced concrete beam extension, in order to solve the problem of constructing a long and big concrete beam. This beam size problem is one of the challenging problem in terms of setting it in the construction site. We discuss the flexural strength analysis for a joint mechanism in the middle of the beam element in order to ease the installation. The aim of the experiment is to evaluate the flexural strength on the concrete beam. Testing is conducted based on the ASTM C 78 standard, which is the concrete flexural strength test with two exposures due to the existence of a support which exist at the 1/3 of the area (third point loading). In this research we conduct experiment on a total of three samples. The first sample is a full beam with the size of 3000 mm x 250 mm x 350 mm. The second one is the beam with the concrete hollow by the size of 1300 mm x 250 mm x 350 mm. The third one is a beam with the steel sheet extension by the size of 1400 mm x 250 mm x 350 mm. The test result of the three samples shows that the maximum load which can be supported by the full beam is higher compared to other samples. Moreover, the maximum flexural strength which can be supported by the beam with the concrete hollow tube is lower compared to the beam with a steel sheet extension. The fracture pattern behaviour of the middle extension of the concrete beams can be identified.

1. Introduction

The development of the concrete technology has been considerably improved recently in accordance with the problem identified during the construction work. This paper presents the performance analysis of the precast reinforced concrete beam extension, in order to solve the problem of constructing a long and big concrete beam. This beam size problem is one of the challenging problem in terms of setting it in the construction site.

Reinforced concrete is a ductile and strong building material, which is easy to be built [1]. Presently, reinforced concrete is usually used for a building structure due to its strength and durability [2]. Concrete is a construction material which is easy to use and presently is on high demand [3]. However, on the other side the material to create this concrete such as cement has been increase and causing the environmental problems [4]. The right treatment in using the cement is required so that concrete can be a sustainable construction material which is sustainable from production process [5]. Subsequently the treatment should ensure sustainability during the lifetime of the structure to the time it becomes waste material.
In this research, we have applied concrete fiber using used tire. The fiber from the used tire has more than one dimension (long). Two or more fiber sizes inside the concrete is expected to optimize the function of the fiber in the cement paste [6]. Therefore, a stronger and ductile material can be created compared to use of only size material. In addition, theoretically in this research we focus on the application of knockdown frame product structure [7].

The expected result of the product is a framed reinforced concrete which can be combined using knock down method, with appropriate features, low cost, and having a technical competitive advantage compared to conventional frame structure [8]. A concrete building with a big dimension requires high quality material [9]. The use of the normal cement will lead to heavy and high cost structure element [10]. Moreover, it will not be optimum, due to the fact that the weight of the concrete is relatively heavy [11]. The use of concrete as a construction material can reduce the use of cement. Cement production process produces acid which is dangerous and causing damage to the ozone layer, leading to a global warming. The reduction of the cement content can also be done using pozzolan [12] such as the Lapindo Mud found in east Java. Other local materials can be used as pozzolan, such as the sand of Merapi Mountain in Central Java which are available abundantly in nature.

2. Research methodology

We conduct some experiments to evaluate the effect of different testing parameters. Subsequently we analyze the data to conclude the result by using the statistical data analysis. The test materials used in this research is in the shape of a beam with the size of 1300 mm x 250 mm x 350 mm and joint concrete hollow by the size of 400 mm x 250 mm x 350 mm.

Table 1. The test material for flexural strength test.

| Testing Type | The Sample Shape | Sample Code | Lapindo Mud Variation* | Merapi Mountain Sand Variation** | Total |
|--------------|------------------|-------------|------------------------|-------------------------------|-------|
| Flexural Strength | Beam of 3 m | BU | 5 % | 100 % | 1 |
|                | Beam 1,3 x 0,25 x 0,35 m | BSH | 5 % | 100 % | 2 |
|                | Beam 1,4 x 0,25 x 0,35 | BSB | 5 % | 100 % | 2 |
|                | Beam 0,4 x 0,25 x 0,35 m | BHB | 5 % | 100 % | 2 |

* % of the cement weight  
** % of the fine aggregate

The aim of the experiment is to evaluate the flexural strength on the concrete beam. Testing is conducted based on the ASTM C 78 standard, which is the concrete flexural strength test with two exposures due to the existence of a support [13] which exist at the 1/3 of the area (third point loading).

Figure 1. Testing of the flexural strength of the whole beam.
3. Result and discussion

The first testing is conducted to identify the material characteristic before it is being used in the cement mix process. The material characteristic will determine the concrete features. On completing the first test, we will know that the material used is in accordance with the requirement and has passed the test.

In this flexural test, we use 3 samples, i.e., whole beam/without extension, sample beam with the concrete hollow extension, and sample beam with a steel sheet extension. The aim of this test is to find \( P_{\text{max}} \) which can be received by the third sample structure, and the size of the flexural rigidity in the middle of the beam.

Figure 2. Testing of the flexural strength of the concrete hollow.

Figure 3. Testing of the flexural strength of the test material with steel sheet extension.

Figure 4. Fracture pattern of the whole beam flexural strength test.
In Figure 4 we know that the fracture pattern happened in the pull side of the beam. This happens due to the effect of the weight P which has to be supported by the beam.

![Figure 5](image)

**Figure 5.** Fracture pattern of the beam with concrete hollow extension flexural strength test.

Figure 5 depicted the fracture pattern happened in the concrete hollow extension. This is due to the fact the hollow beam is not strong enough to support the weight.

![Figure 6](image)

**Figure 6.** Fracture pattern of the beam with concrete using steel sheet extension flexural strength test.

From Figure 6 it can been found that no fracture happened in the beam. A deformation in the form of an arc happened to the steel sheet extension in pull area.

![Figure 7](image)

**Figure 7.** Comparison of the weight received by each test materials.

The comparison of the flexural strength and the weight which must be supported by the three test material is clearly shown in Figure 7.
We compared the flexural strength of each test materials, based on the calculation. From the testing it has been found the flexural strength of the beam with steel sheet extension is larger than the flexural strength in the beam with concrete hollow extension. The comparison of each flexural strength of each test material can be found in Table 2.

| Test Materials                        | $R_A$ (kg) | $M$ (kg.cm) | $\Sigma_{\text{flexural}}$ (kg/cm²) |
|---------------------------------------|------------|-------------|-------------------------------------|
| Whole Beam                            | 7263,375   | 65712,0625  | 12,874                              |
| Beam with concrete hollow extension   | 2043,25    | 35740,875   | 7,002                               |
| Beam with steel sheet extension       | 2525       | 15625       | 3,061                               |

4. Conclusion
From the result of the research work on the flexural strength of precast reinforced concrete beam using fiber, mud, and sand as an additive, it can be summarised that we can identify the fracture pattern behaviour of the middle extension of the concrete beam. The test result of the three test materials shows that the maximum weight of the test material which can be supported by the beam is larger compared to other test materials. In the future work we will design a concrete hollow to evaluate the strength of the concrete hollow extension.

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