EXPERIMENTAL INVESTIGATION OF DUCTILITY OF REINFORCED CONCRETE BEAMS STRENGTHENED WITH POLYPROPYLENE FIBERS

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Abstract: The purpose of this study is to research both the performance of the reinforced concrete beams without fiber and the performance of the reinforced concrete beams with fiber. For this purpose, the experimental load - displacement curves of beams were formed and the areas under these curves were compared. According to the results of this comparison, it is concluded that the reinforced concrete beams with polypropylene fiber are more ductile. The dimension of the used beam-samples for test in this study is 20x30 cm, their length is 200 cm and their scale is ½. The reinforced concrete reference-beams are produced as two items and the reinforced concrete beams with P-0.60 kg/m^3 polypropylene fiber are produced as three items.

Keywords: Polypropylene, Fiber-reinforced beams, Strengthening of the beams.

Introduction

The tensile strength and ductility of concrete is low. This weakness of concrete has emerged an idea “the concrete-strengthening with different fibrous materials”. For this purpose, different fibrous materials have been developed. One of these developed materials is a polypropylene fiber material. There are different studies about polypropylene fiber materials in the literature. These studies are given below in the following. Aktürk (2006) has researched the performance-characteristics of polypropylene fiber reinforced and self-compacting concretes. Altun (2006) has experimentally analyzed the effect of the steel fiber additive on the ultimate bearing capacity for the elements of reinforced concrete beams. Akkas (2010) has investigated the compressive strength-properties of polypropylene fiber reinforced concretes and half-lightweight concretes. Arazsu (2012) has researched the fresh and hardened concrete-properties of polypropylene fiber reinforced concretes. Açıkgenç (2012) has researched the strength and durability characteristics of polypropylene fiber reinforced concretes in the different mix proportion.

Materials and Methods

In this study, the polypropylene fibers are used to increase the tensile strength and ductility of the concrete. The reinforced concrete reference beams without fiber and the reinforced concrete beams with polypropylene fibers P-0.60 kg/m^3 were experimentally compared to each other in these experimental studies. The additive amount of polypropylene fibers P-0.60 kg/m^3 in this experimental study requires to be used at least 600 gr additive of polypropylene fibers for reinforced concrete beams in the size of 1m^3. Therefore, total 216 gr additive of polypropylene fibers was used for three items “reinforced concrete beams” in the size of 0.36 m^3. The load - displacement curves of reinforced concrete beams were obtained in these tests.

Properties of The Used Polypropylene Fibers In Tests

Polypropylene fibers are produced in a wide variety of dimensions. Their raw material is 100 % polypropylene. The produced varieties of these polypropylene fibers in length of 6 mm, 12 mm, 19 mm and 38 mm are less filamentous. The polypropylene fibers in length of 12 mm were used in this experimental study. The used fibers for research are provided by company İzmit BEKSA. These fibers are not produced in Turkey. They are currently produced by the company Dramix in Belgium. This company is represented by company BEKSA in Turkey.

Test Arrangement and Measuring Technique

The used experimental arrangement in this study is a bending test instrument. The load cell in capacity of 500 kN was used for this arrangement and the displacements were measured by 15- 20 cm LVDTs. The produced reinforced

concrete simple beams are supported at both ends and the weight is loaded as two items in the distance of L/3. The used LVDTs in test were placed as two items on the beam- supports and under the central part of the beam. (Fig. 1).

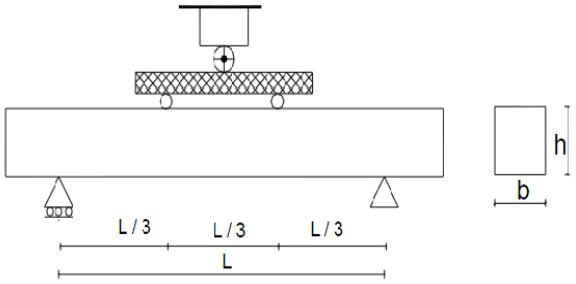

Fig. 1 Test Arrangement

Test Results

In this experimental study, two samples for reinforced concrete reference beam and three samples for reinforced concrete with P-0.60 kg/m^3 polypropylene fibers are produced. These produced beams were loaded with two items "P weight" from L/3 points and the loading has continued increasing 10 kN to the yield load from scratch. After yield load, the weight was loaded to form a deflection with the addition of 1cm. This loading is continued to collapse-load. Later the load - displacement curves were drawn with the program TDG CODA. The charts of obtained results were drawn with Excel program.

Showing of Average Values of Reinforced Concrete Reference-Beams (A,B)

The weight was loaded increasing 10 kg Newton from scratch to the reinforced concrete reference beams (A,B) and they began to crack on average 40.45 kN. The loading was continued and the yield load was reached at 167.10 kN. Maximum load and displacement was the value of 166.70 kN and 62.68 mm. According to the average of two concrete reference beams in this experimental study, the following chart was drawn (Fig. 2-4).

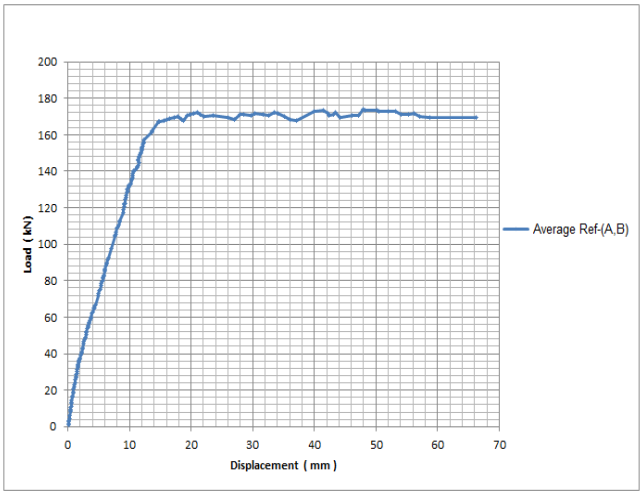

Fig. 2 The Average Load - Displacement Curve of The Reinforced Concrete Reference Beam (A,B)

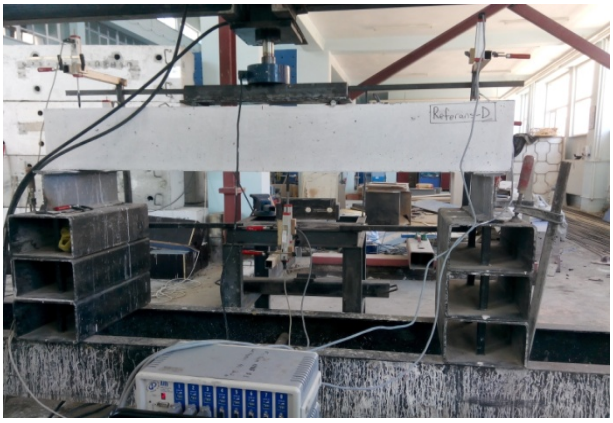

Fig. 3 The Situation of Reinforced Concrete Reference Beam (A) before loading

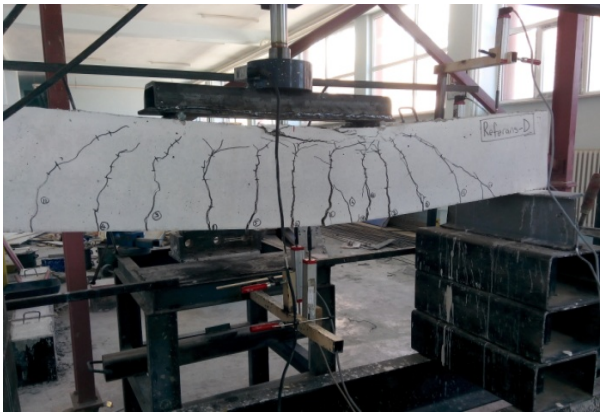

Fig. 4 The Collapse Situation of Reinforced Concrete Reference Beam (A)

Showing of Average Values of Reinforced Concrete Beams With Polypropylene Fiber P-0.60 kg/m^3 - (A,B,C)

The additive amount of polypropylene fibers P-0.60 kg/m3 in this experimental study requires to be used at least 600 gr additive of polypropylene fibers for reinforced concrete beams in the size of 1m^3. Therefore, total 216 gr additive of polypropylene fibers was used for three items "reinforced concrete beams" in the size of 0.36 m^3. The weight was loaded increasing 10 kg Newton from scratch to the reinforced concrete reference beams P-(A, B, C)- 0.60 kg/m^3 and they began to crack on average 50.73 kN. The loading was continued and the yield load was reached at 154.43 kN. Maximum load and displacement was the value of 170.67 kN and 62.00 mm. According to the average of three reinforced concrete beams-P-0.60 kg/m^3 in this experimental study, the following chart was drawn. (Fig. 5-7).

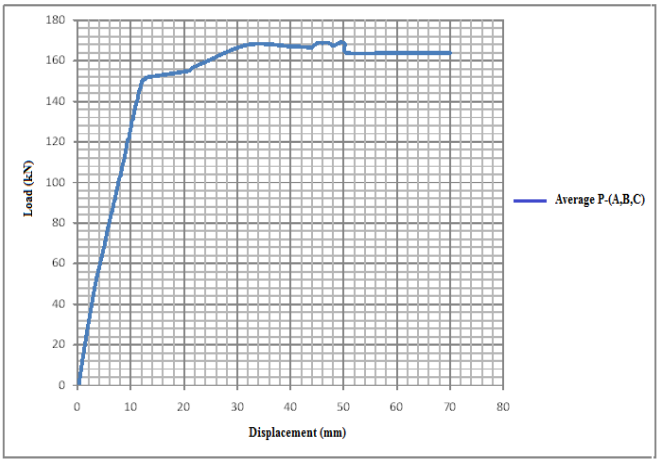

Fig. 5 The Average Load-Displacement Curve of The Reinforced concrete P–0.60 kg/m^3 Beam (A,B,C)

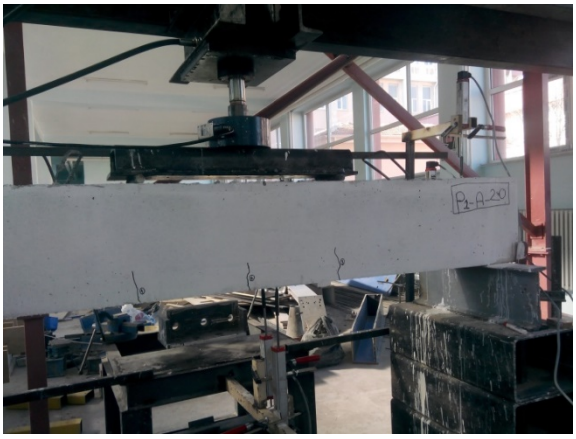

Fig. 6 The Situation of Reinforced Concrete P–0.60kg/m^3 Beam (A) before loading

Fig. 7 The Collapse Situation of Reinforced Concrete P–0.60 kg/m^3 Beam (A)

The chart comparison of P-0.60 kg/m^3 – (A,B,C) and reference (A,B) beams

In this study, three items "Reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3" and two items "Reinforced concrete reference-beams" are produced. According to their average, the following charts were drawn. As shown in the following chart of these two beams, the yield-strength of reinforced concrete reference-beam is higher and more ductile than the yield-strength of reinforced concrete beam P-0.60 kg/m^3-(A,B,C). However, the maximum displacement values of results are close to each other (Fig. 8).

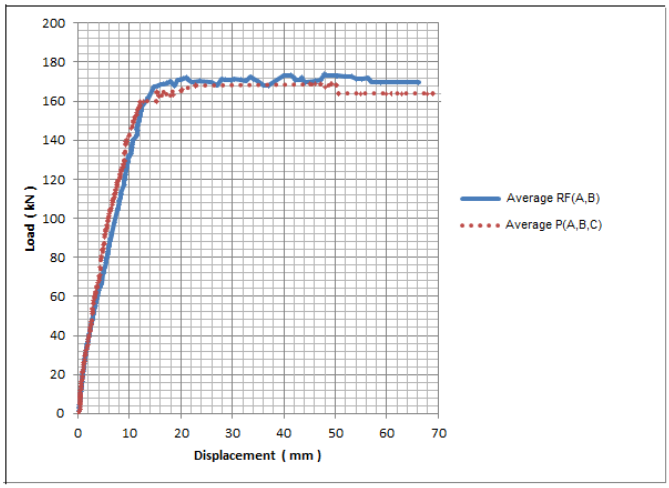

Fig. 8 The Average Load - Displacement Curve of P-0.60 kg/m^3– (A,B,C) and Reference (A,B) Beams

Conclusion

According to experimental research in this study, two items "reinforced concrete reference beams without fiber" and three items "reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3" are produced. Dimensions of the produced reinforced concrete beams are 0.20x0.30 m^2, their length is 2m and their scale is ½. The reinforced concrete beams were loaded with two items weight from L/3 point in the experimental researches and the displacements were measured from the middle of beam. According to these measurements, load-displacement curves of reinforced concrete beams were drawn. Then energy absorption capacity and ductility of reinforced concrete beams are learned and the results were compared to each other. According to this comparison, energy absorption capacity of reinforced concrete reference beams is higher than energy absorption capacity of reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3 and ductility of reinforced concrete reference beams is lower than ductility of reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3. While the energy absorption capacity and ductility coefficient of reinforced concrete reference beams are in turn 9912 kNmm and the value of 4.71, the energy absorption capacity and ductility coefficient of reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3 are 10076 kNmm and the value of 5.83. The energy absorption capacity of reinforced concrete reference beams with polypropylene fiber P-0.60 kg/m^3 is higher % 2 than energy absorption capacity of reinforced concrete reference beams and ductility of reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3 is higher % 23 than ductility of reinforced concrete reference beams. According to these results, it is concluded that the reinforced concrete beams with polypropylene fiber P-0.60 kg/m^3 are more ductile and their earthquake performance is better.

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