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The Experimental Analysis of the Textile Reinforced Concrete

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Abstract: This article deals with experimental testing of the textile reinforced concrete samples. The main topic of this article is determination ultimate tensile strength of the textile reinforced concrete. The testing samples were in form as "dogbone" for good fixing in testing machine. There are 12 samples in experimental program. One type cement matrix and three types (difference in their weight 125 g/m^2, 275 g/m^2 and 500 g/m^2) glass textile reinforcement were used for the production of dogbone samples. The samples were tested by special attachment by axial tensile load. Experimental tests were controlled by speed of rate of deformation (0.0005 mm/min).

Keywords: Textile Reinforced Concrete; Tensile Strength; Dogbone Specimen; Cement Matrix.

1 Introduction

The textile reinforced concrete is new building material for constructions in modern civil engineering [1]. The textile reinforced concrete consists of cement matrix and textile reinforcement. The cement reinforced concrete has a lot of advantages. The textile reinforced concrete has corrosion resistance and due to textile reinforcement it has ductile behaviour in plastic region of stress-strain diagram. It is necessary to know mechanical properties and behaviour during loading for expansion in civil engineering. This article deals with determination of maximal tensile strength and stress-strain diagrams of textile reinforced concrete samples.

The cement matrix composition is similar to high strength concrete composition. There are a lot of scientific researches based on determination of tensile strength of high performance concrete [2, 3]. J. Hartig studied different experimental samples for determination tensile strength of textile reinforced concrete [4]. The dogbone specimens produced good results and therefore dogbone is good sample for determination of tensile strength fibre reinforced high performance concrete or textile reinforced concrete. The size effect were studied in [5]. Van Vliet et al. find relation between sample shape and results.

2 Experimental Program - the Cement Matrix and the Textile Reinforcement

Totally there were made 12 textile reinforced concrete samples for determination one-axial tensile strength. Specimens for experimental program are made like a shape of a "dogbone" with dimensions in the middle of a specimen: 30 × 30 mm (Fig. 1).

One type cement matrix and three types glass textile reinforcement were used for the production of samples. There is one cement matrix in experimental program. The cement matrix was developed in Experimental Centre for special use for production of textile reinforced concrete elements [6]. The composition of cement matrix is similar to high performance concrete composition. The exact composition is written in Tab. 1. The weight ratio relating to cement is in the second column. The amount of components in one cubic meter is written in the third column. The production of cement matrix is technologically very demanding. It is always necessary to strictly follow a prescribed procedure for mixing all components. Especially time for mixing the components must be strictly adhered. The main compressive strength determined on cubes 100 × 100 × 100 mm is 102.2 MPa and the main tensile strength determined by three point bending test on prisms 160 × 40 × 40 mm is 15.7 MPa [7].

The textile reinforcement was made by Adfors Saint-Gobain Company. This textile reinforcement can be used in concrete elements, wall reinforcement etc. The textile reinforcement has a lot of advantages and is

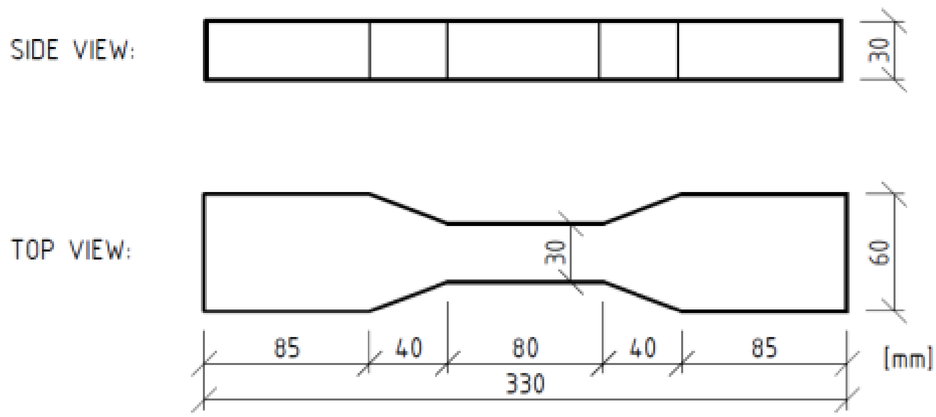

Fig. 1: Dogbone specimen.

Tab. 1: Composition of cement matrix.

component	Weight ratio	Weight of component
	[-]	[kg/m^3]
cement CEM I 42.5 R	1	680
microsilica	0.19	129
silica sand 0.1/0.6	0.48	326
silica sand 0.3/0.8	0.50	340
silica sand 0.6/1.2	0.38	285
silica powder ST6	0.48	326
superplasticizer	0.01	6.9
water	0.35	238

made of alkali resistant glass fibres with high tensile strength [8]. There are three types of textile reinforcement in experimental program. All of them are made of glass fibres vary only in basis weight. We used R 131 A 101 (131 g/m^2), R 275 A 101 (275 g/m^2) and R 585 A 101 (585 g/m^2).

There were 12 dogbone samples in experimental program. Three dogbone samples were made of cement matrix without any textile reinforcement. Nine dogbone samples were made of cement matrix reinforced by two layers of textile reinforcement. Three dogbone samples were reinforced by two layers of each type of textile reinforcement (R 131, R 275 and R 585).

3 Experimental Program – Testing of Samples

The textile reinforced concrete samples were tested by loading press FPZ 100/1. Dogbone samples were mounted in a special gripper.

The samples were loaded by axial tensile load. The tests were controlled by deformation. Speed of deformation was 0.5 mm/min. The deformation were recorded by high-speed camera Prosilica GF to ensure a good accuracy of deformation. The camera captured two points on dogbone sample for determination deformations. Results of testing are summarized in next table (Tab. 2). There are results of group of three samples in the table. Each value of maximal tensile strength is an average value of three samples. There is a standard deviation of maximal tensile strength in the fourth column.

It is obvious, that maximal tensile strength are similar to each of groups. The maximal tensile strength were been reached by first crack. The maximal tensile strength corresponds to tensile strength cement matrix without textile reinforcement. The textile reinforcement are good for ensuring ductile behaviour and plastic deformation of textile reinforced concrete. There are collapsed samples in next pictures. Fig. 2 shows collapsed dogbone sample without textile reinforcement. The collapse of the sample occured immediately after first crack. Fig. 3

Tab. 2: Results of textile reinforced concrete loaded by tensile strength.

dogbone sample	type of reinforcement	max. tensile strength	standard deviation
	[-]	[MPa]	[MPa]
cem. matrix	-	5.1	1.2
R 131	2 × R 131	5.6	0.4
R 275	2 × R 275	6.0	1.1
R 585	2 × R 585	4.7	0.2

shows dogbone sample with textile reinforcement R 585. In this case there is visible a large ductile area in a crack of sample.

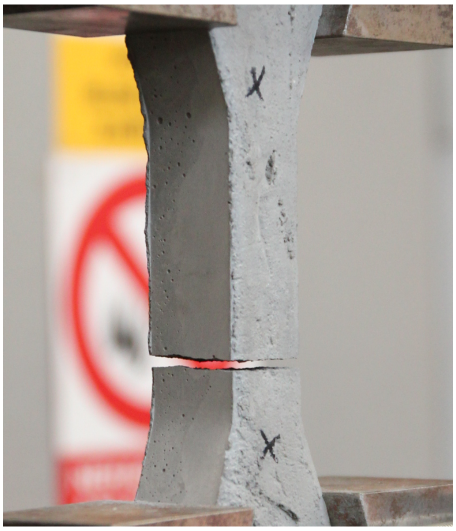

Fig. 2: Dogbone without textile reinforcement.

Fig. 3: Dogbone with textile reinforcement R 585.

Ductile behaviour can be shown in the next chart (Fig. 4). There are four curves in this chart. We can observe an increasing trend of plastic deformation of samples reinforced R 275 and R 585 textile reinforcement. In chart there is an elastic area on the left side. The elastic area is drawn by vertical line, because the relative strain in point of maximal tensile strength is approximately 0.00015. It created crack after reaching maximal tensile strength. The cement matrix without textile reinforcement was destroyed after that. The dogbone samples with textile reinforcement have plastic deformation, but tensile strength not reached maximal value of tension strength.

4 Conclusion

The article deals with topic of testing of textile reinforced concrete. The textile reinforced samples were loaded by axial tensile load for determination maximal tensile strength. There was used one type of cement matrix and textile reinforcement made of high strength alkali-resistance glass fibres. Totally 12 dogbone samples were made for this experimental program. Three dogbone samples were made of cement matrix without any textile reinforcement. Nine dogbone samples were made of cement matrix reinforced by two layers of textile reinforcement. Three dogbone samples were reinforced by two layers of each of type of textile reinforcement (R 131, R 275 and R 585).

The maximal tensile strength of cement matrix without textile reinforcement is 5.1 MPa. The maximal tensile strength is 5.6 MPa in case of samples reinforced by textile reinforcement R 131, 6.0 MPa in case of R 275 textile reinforcement and 4.7 MPa in case of R 585 textile reinforcement. The maximal strength are similar to each of group of samples. The maximal tensile strength correspond to tensile strength cement matrix

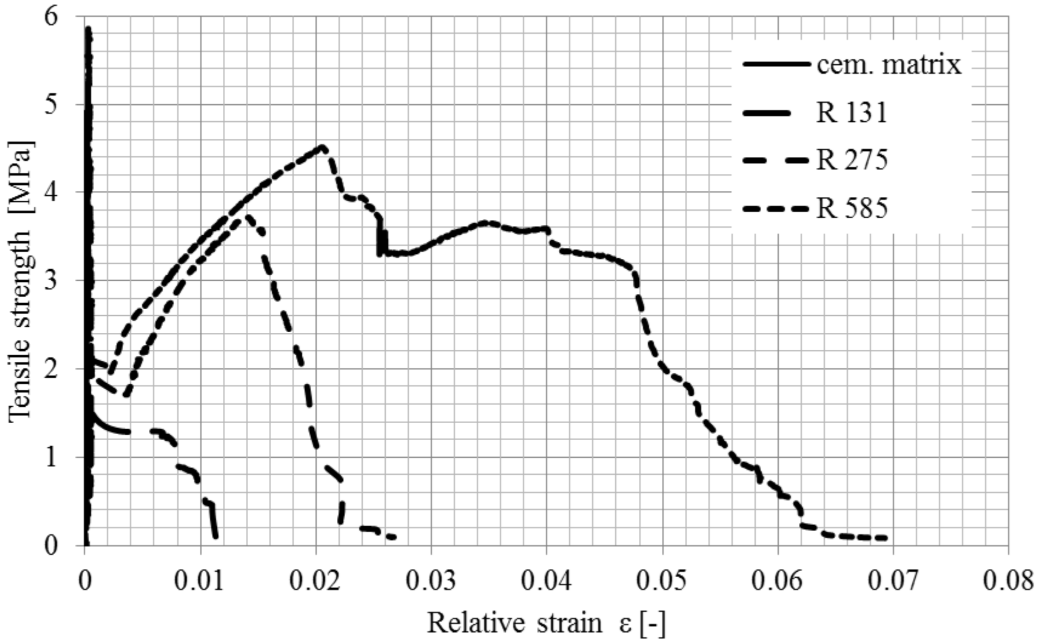

Fig. 4: Stress-strain diagrams of each of type dogbone samples.

without textile reinforcement. The textile reinforcement are good for ensuring ductile behaviour and plastic deformation of textile reinforced concrete.

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