FRACTURE PROPERTIES OF FIBRE UHPC AFTER 28, 90 AND 180 DAYS OF SPECIMENS CURING

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Abstract

A new category of high strength concrete was developed in a few past years – Ultra High Performance Concrete (UHPC). For the UHPCs is typical compressive strength of 150 MPa and above, and tensile strength of 20 MPa and above. These properties are allowed due to special composition of the concrete containing dispersed metallic fibres. Presented paper introduces values of fracture properties of the concrete after 28, 90 and 180 days of specimens curing.

Keywords: Ultra high performance concrete; fracture properties; age of specimens.

1 Introduction

To obtain values of fracture properties of tested UHPC specimens, suitable tools of fracture mechanics was applied [1–4]. Effective fracture toughness was measured using the *Effective Crack Model*. It is known, this model combines the linear elastic fracture mechanics and the crack length approach. A three-point bending (3PB) test of beams with a central edge notch was used, and continuous record of the load–deflection (F–d) diagram was obtained for computation of this value. The notch was cut before testing. An estimation of fracture energy was computed from an F–d diagram according to the RILEM method – see e.g. [1].

2 Results

The ultra high performance concrete was designed. This composite is based on the ordinary Portland cement, silica fume, quartz sand and special polycarboxylate superplasticizers. Another important part of the concrete composition is steel fibres with the length 6 and 12 mm which give to this UHPC needed compressive and chiefly tensile strength. Properties of different variants of the UHPC (the difference lies in different length of steel fibres) were carefully observed and some of the basic fracture properties are shown in the following tables and figures. There are standardly mean values, standard deviations and coefficients of variability (COV) presented. The effective fracture

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toughness is presented in the Table 1 and Fig. 1, the effective toughness is presented in the Table 2 and Fig. 2, and fracture energy in the Table 3 and Fig. 3.

Effective Fracture Toughness		without fibres			fibres 6 mm			fibres 12 mm		
		28	90	180	28	90	180	28	90	180
Mean Value	[MPa.m$^{1/2}$]	1.276	1.327	1.255	1.049	1.201	1.789	1.685	1.932	9.245
Standard Deviation	[MPa.m$^{1/2}$]	0.030	0.004	0.068	0.184	x	x	0.225	0.200	0.812
COV	[%]	2.3	0.3	5.4	17.6	x	x	13.3	10.4	8.8
Relative Values	[%]	100.0	104.0	98.4	100.0	114.5	170.6	100.0	114.7	548.5
		100.0	100.0	100.0	82.2	90.5	142.5	132.1	145.6	736.6

Tab. 1 Effective fracture toughness

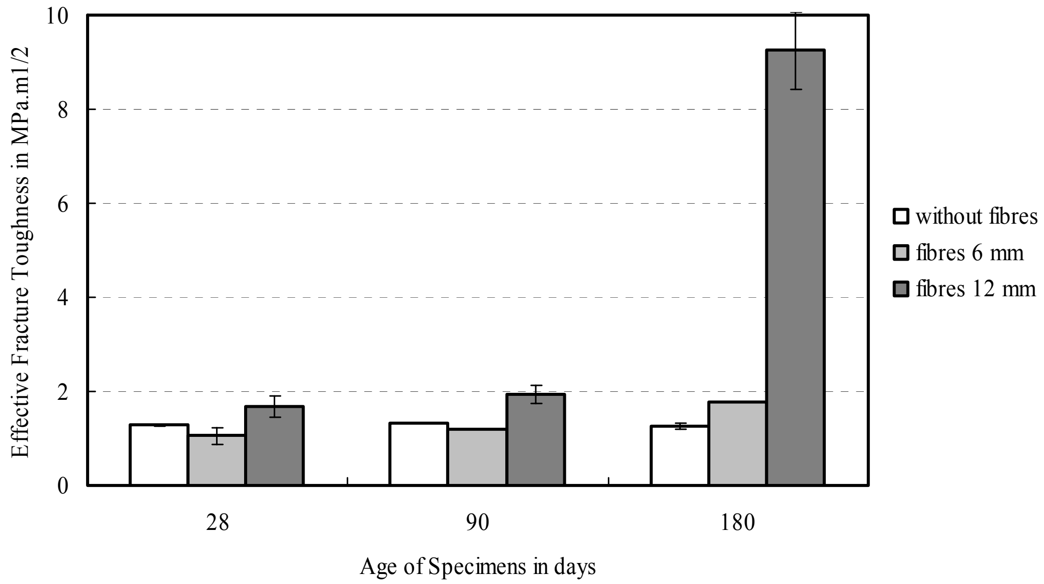

Fig. 1 Effective fracture toughness vs. age of specimens

Effective Toughness		without fibres			fibres 6 mm			fibres 12 mm		
		28	90	180	28	90	180	28	90	180
Mean Value	[J/m^2]	30.3	31.6	27.0	22.3	26.8	69.0	57.2	64.2	2511.5
Standard Deviation	[J/m^2]	1.3	2.8	2.5	7.9	x	x	16.0	15.9	163.3
COV	[%]	4.2	9.0	9.2	35.6	x	x	27.9	24.8	6.5
Relative Values	[%]	100.0	104.1	89.0	100.0	120.2	309.0	100.0	112.3	4391.0
		100.0	100.0	100.0	73.6	85.0	255.8	188.6	203.5	9310.5

Tab. 2 Effective toughness

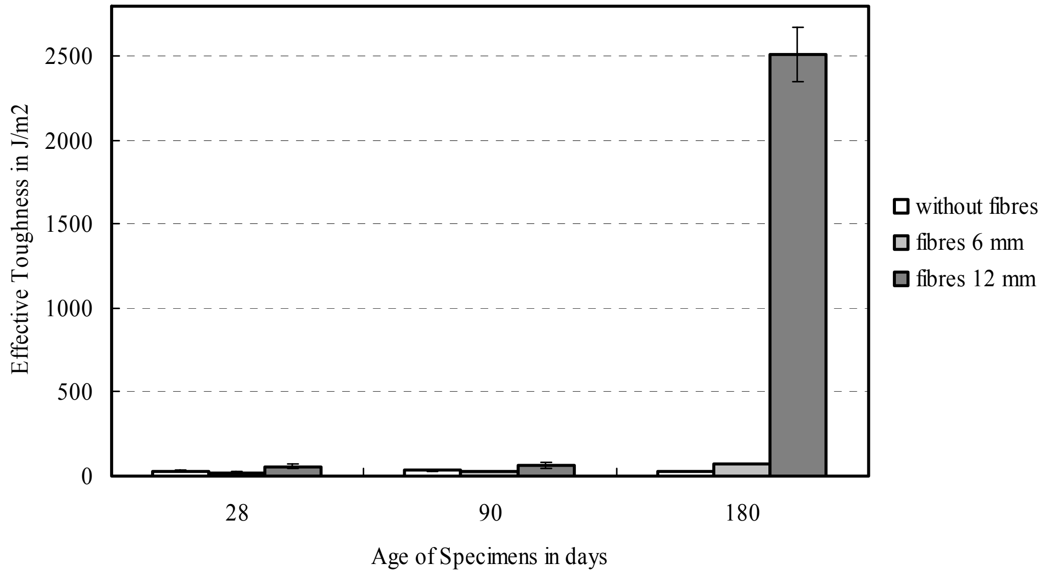

Fig. 2a Effective toughness vs. age of specimens

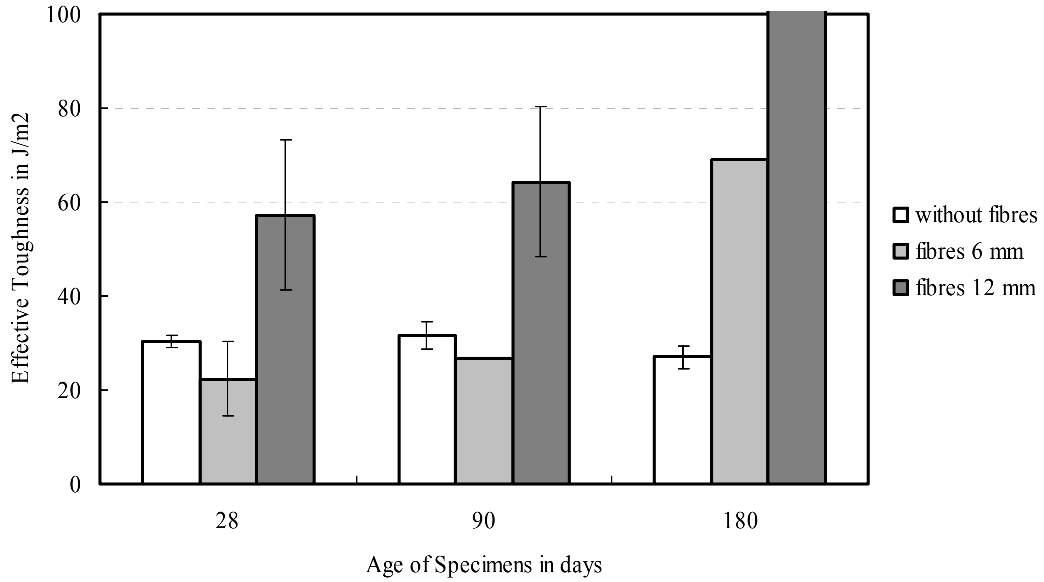

Fig. 2b Effective toughness vs. age of specimens (detail)

Fracture Energy		without fibres			fibres 6 mm			fibres 12 mm		
		28	90	180	28	90	180	28	90	180
Mean Value	[J/m^2]	19.4	16.8	11.0	2003.7	2074.3	2890.0	4302.0	7322.0	5763.0
Standard Deviation	[J/m^2]	2.5	2.9	0.8	458.8	299.4	181.0	499.1	173.9	1093.2
COV	[%]	13.0	17.4	6.9	22.9	14.4	6.3	11.6	2.4	19.0
Relative Values	[%]	100.0	86.8	56.9	100.0	103.5	144.2	100.0	170.2	134.0
		100.0	100.0	100.0	10346.8	12335.0	26236.9	22215.3	43540.1	52319.6

Tab. 3 Fracture energy

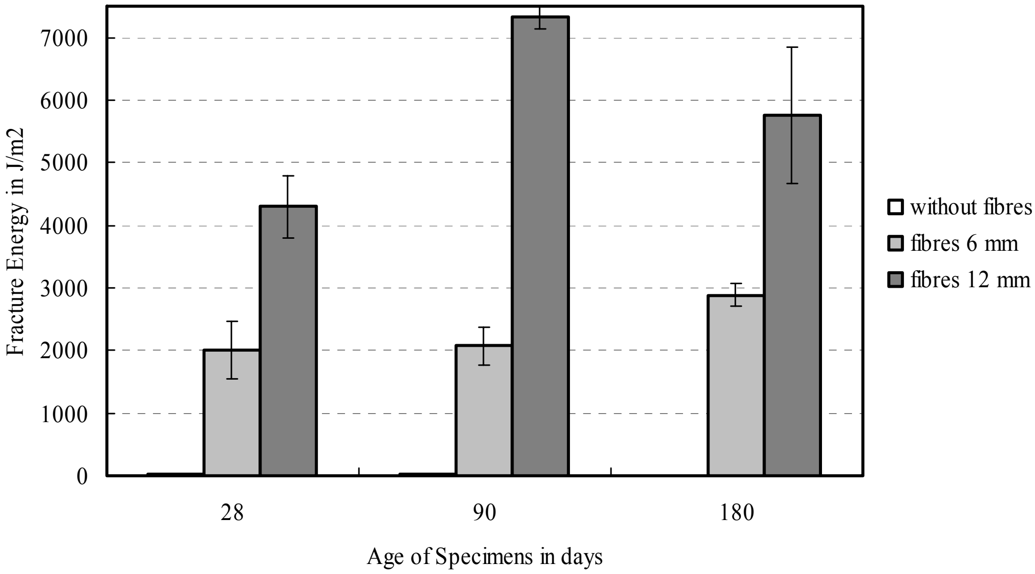

Fig. 3 Fracture energy vs. age of specimens

3 Conclusions

From the above-presented results it is possible to conclude:

- In the UHPC included steel fibres have significant effect on values of fracture properties of tested concretes.
- The addition of fibres is reflected by fracture properties values in a positive way.

Acknowledgements

This outcome has been achieved with the financial support of the Ministry of Education, Youth and Sports, project No. 1M0579 – CIDEAS research centre and with the financial support of the project FI-IM/185 of the Ministry of Industry and Trade.

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