FRACTURE-MECHANICAL PARAMETERS VALUES OF SPECIAL CEMENT BASED FIBRE-COMPOSITES

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Abstract:

The paper presents values of selected fracture-mechanical parameters of various types of special cement based fibre-composites developed in a current stage of a long-lasting research which is aimed on special applications of composites with electrically conductive admixtures.

Keywords: cement based fibre-composite (with electrically conductive admixture), fracture parameters

1 Introduction

Selected values of fracture-mechanical parameters (effective fracture toughness and fracture energy) of five types of special composites are presented and compared in the paper. Described experiments were performed in order to compare the fracture-mechanical parameters values of composites for the special applications selected according to the electrical features (investigated simultaneously in a specialized laboratory) which are developed by VUSTAH (i.e. Research Institute of Building Materials) and to recommend the composites suitable from the fracture-mechanical point of view for the next stages of the research. During these experiments some useful experiences with the influence of carbon particles and their combination on values of fracture-mechanical parameters of cement based composites were obtained.

2 Test procedures

Effective fracture toughness was measured using the Effective Crack Model [1]. This model combines the linear elastic fracture mechanics and effective crack length approaches. A three-point bending (3PB) test of a specimen with a central edge notch is used in this approach. The nominal size of the notched beams is 50×10×250 mm, the depth of the central edge notch is about 1/3 of the depth of the specimen, and the loaded span is equal to 200 mm (Fig. 1). A continuous record of the load–deflection (F–d) diagram was obtained for computation of this value. Note that large deflections were obtained during the tests. An estimation of the fracture energy was computed from the recorded F–d diagram according to the RILEM method (work-of-fracture). See e.g. [2] for more details.

The mixture contents for each composite are reported in Table 1. These mixtures

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resulted from the cooperation of VUSTAH and laboratory specialized on electrically conductive admixtures and their properties. The first (*NK 13f*) as well as the second (*NK 14f*) composite contains 7.6 % (mass ratio) of fine-grained carbon particles (i.e. 10 % of dry mixture), while the third one (*NK 17f*) contains 1.5 % of this particles (i.e. 2 % of dry mixture). Carbon fine-grained particles signed as *CR2 995* were employed in the case of *NK 13f*, particles *COND 896* were than used in the case of *NK 14f*. For *NK 17f*, expanded graphite was added. A combination of two types of carbon particles were used in cases of *NK 54d* and *NK 55d* – CR2 995 (4.2 % for *NK 54d* and 4.0 % for *NK 55d*) and carbon particles (0.2 % and 0.5 %).

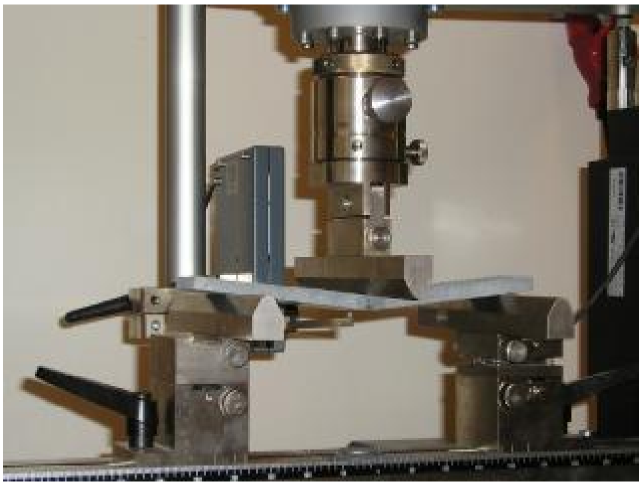

Fig. 1 Configuration of the three-point bending test

Tab. 1 Studied material – batch contents (mass ratios)

	Batch contents in %				
	NK 13f	*NK 14f*	*NK 17f*	*NK 54d*	*NK 55d*
Cement CEM I 52.5	37.3	37.3	39.7	38.5	38.5
Fine-grained aggregate 0–1 mm	28.7	28.7	30.5	29.2	29.2
Fine-grained admixtures	2.0	2.0	2.2	2.0	2.0
Alkali resistant glass fibres	2.3	2.3	2.4	2.2	2.2
Carbon particles (different type for each batch)	7.6	7.6	1.5	4.4	4.5
Superplasticizer	1.4	1.4	1.5	2.5	2.5
Water	20.7	20.7	22.2	21.2	21.1

3 Experimental results

Fracture behaviour of studied composites can be distinguished by the courses of load–deflection diagrams (Fig. 2) and quantified by the values of fracture parameters [3] (Tab. 2). Based on these results we can select composites more suitable from the fracture-mechanical point of view for the next stages of the research, and continuously, we can monitor the influence of used carbon particles and their combination on values of the fracture parameters of cement based composites.

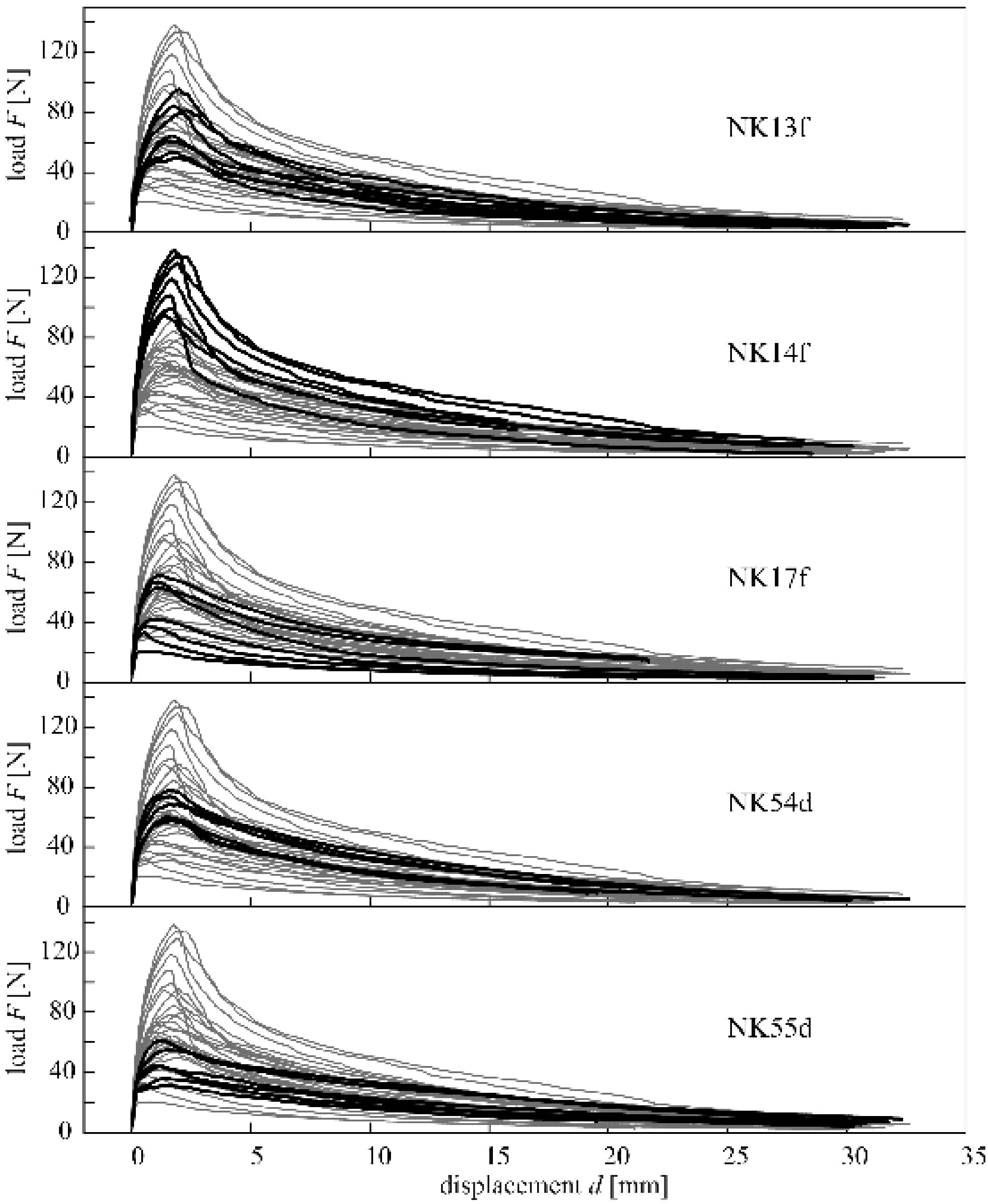

Fig. 2 Load–deflection diagrams

Tab. 2 Values of selected fracture parameters: mean and coefficient of variation (COV)

	Set	Arithmetic mean	COV [%]
Effective fracture toughness [MPa.m$^{1/2}$]	*NK 13f*	2.20	10.6
	NK 14f	2.68	9.4
	NK 17f	1.25	21.3
	NK 54d	2.52	17.2
	NK 55d	1.84	13.2
Specific fracture energy [J/m^2]	*NK 13f*	2039	24.1
	NK 14f	2581	27.9
	NK 17f	1099	42.5
	NK 54d	2047	21.8
	NK 55d	1699	33.3

4 Conclusions

Composite *NK 14f* shows the highest values of effective fracture toughness as well as specific fracture energy. When we consider composites with a combination of two types of carbon particles (CR2 995 and carbon particles which seems to be more suitable from electrical features point of view), we can point out composite *NK 54d*. It seems that the suitable amount of carbon particles can improve the fracture-mechanical parameters, but on the other hand oversized amount of carbon particles leads to lower values of fracture-mechanical parameters.

Acknowledgements

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