COMPARISON OF MECHANICAL AND PHYSICAL CHARACTERISTICS OF THE LIGHTWEIGHT CONCRETE WITH AND WITHOUT FIBRES

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Abstract

The contribution presents results from destructive and non-destructive experimental tests on specimens from lightweight concrete with fibres, which are compared with tests results on specimens from lightweight concrete without fibres. As an aggregate an inland-made porous aggregates Liapor and heavy-weight aggregates with maximal grains of 8 mm was used. According to CSN P ENV 206 the reference concrete conform to the grade of concrete LC 45/50 with density 1800 kg/m3. As a dispersed reinforcement a polypropylene fibres Forta Ferro of 54 mm length and tensile strength of 620 – 758 MPa was used.

Keywords: Lightweight Concrete; polypropylene Fibres; Modulus of Elasticity.

1 Introduction

Plain concrete is a brittle material, with low tensile strength and strain capacities. To help overcome these problems, there has been a steady increase over the past twenty years in the use of fibre reinforced cements and concretes (FRC). Their role is to control the cracking of FRC and to alter behaviour of the material once the matrix has cracked, by bridging across these cracks and so providing some post-cracking “ductility”. In the last few years many new fibre types have been developed, in order to optimize the properties of the composite. As a result, such composites can now be “tailored” for specific applications for which conventional cementitious systems are not suitable [1].

2 Experimental details

Fresh concrete mixture was prepared from heavy-weight aggregates (HTK) of 4–8 mm fraction, CEM I – 42.5 R cement, fly-ash, micro-silica, plasticizer, water and Liapor CZ/4-8/600 lightweight aggregates. The water, lightweight aggregates and normal-weight aggregates of 4–8 mm fraction were dosed by volume, the remaining components by

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weight. Polypropylene fibres Forta Ferro (FF) of 54 mm length were added to serve as dispersed reinforcement. The scope of the experiments continues from a section published within the proceedings of the conferences “Special Concretes” [2] and “13th Concrete days” [3]. The technological process involved in the dosing of individual components and manufacturing of fresh concrete is presented in details in [3].

2.1 Manufacturing and curing of specimens

The specimens for the tests were manufactured both from lightweight concrete and lightweight fibre-concrete. Cubes of 150×150×150 mm were used for determination of compressive strength after 7 and after 28 days. Prisms of 100×100×400 mm were used for determination of the modulus of elasticity both in compression and in flexure. The values of splitting tensile strengths were determined on fragments of prisms. The technological process of manufacturing and curing is presented in details in [3]. Together, 6 cubes and 14 prisms were manufactured from each type of concrete.

2.2 Determination of the modulus of elasticity in compression and in flexure

Compressive strength was determined for the cubes after 7 and 28 days of aging. The cubes were uniformly loaded up to velocity failure at 11.2 kN/s in a presser of 1600 kN range.

Both the static modulus of elasticity in compression were determined on the prisms, which were loaded in compliance with the Czech standard ČSN ISO 6784 [4]. The modulus of elasticity in flexure was determined in compliance with the Czech standard ČSN 736174 [5]. Based on experience gained from similar tests performed previously, the measuring apparatus was constructed in the form of a flat preparation mounted on the prism, on one end of which a digital indicator of 0.001 mm sensitivity was placed. The indicator measures double values of prism deflection. The prism was loaded to levels that induced stress corresponding to approximately 10% of assumed bending strength. The loading and unloading was carried out continuously according to the designed regime. From the measured deformations we calculated the values of total deflection at the i-th loading level and the values of elastic deflection on the same level. From the general relationship for four-point bending, relevant values of the modulus of elasticity were calculated.

3 Results of Experiments

The results of the tests are given in the following figures. The mean values and coefficients of variability (COV) of the measured characteristics are presented in these figures: the volume density (Fig. 1), compressive cube strength (Fig. 2), modulus of elasticity in compression (Fig. 3), modulus of elasticity in flexure (Fig. 4) and a splitting tensile strength (Fig. 5). The test results of strengths – supplemented by the volume density and modulus of elasticity values – are presented in Table 1.

Tab. 1 Mean values of tested properties of lightweight concretes both with and without fibres

	Volume Density	Compressive Cube Strength		Splitting Tensile Strength	Elasticity Modulus in Flexure	Elasticity Modulus in Compression
		7 days	28 days			
	[kg/m^3]	[MPa]	[MPa]	[MPa]	[GPa]	[GPa]
Liapor CZ + HTK	1850	48	58	3.5	24.0	24.0
Liapor CZ + HTK + FF	1820	49	56	4.7	23.2	22.9

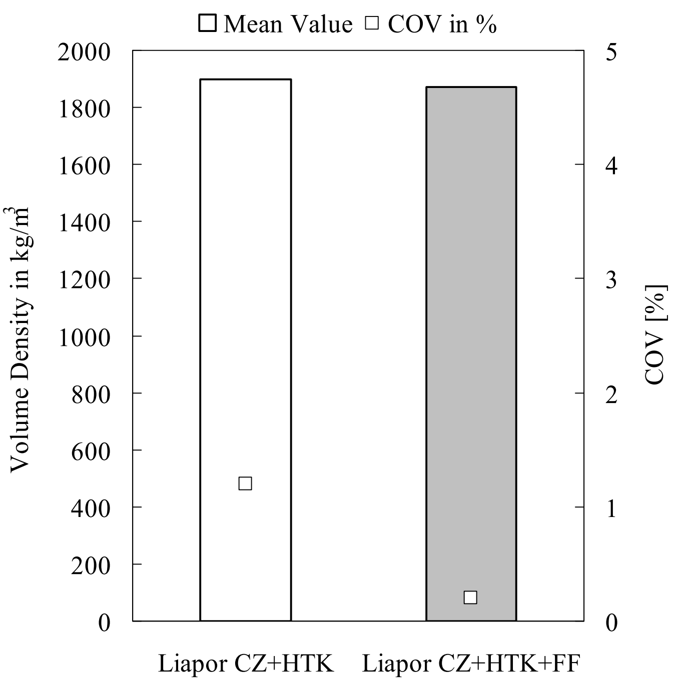

Fig. 1 Mean values of volume density: Mean values and coefficients of variation

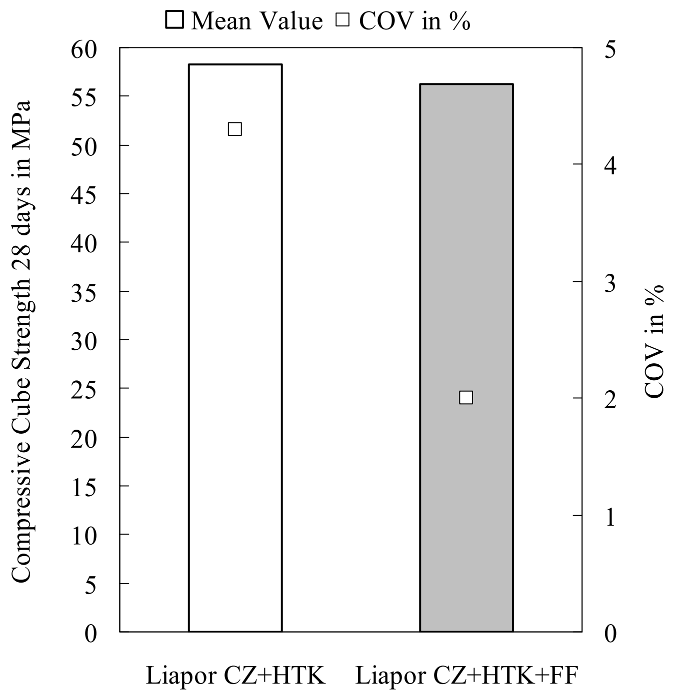

Fig. 2 Mean values of compressive cube strength: Mean values and coefficients of variation

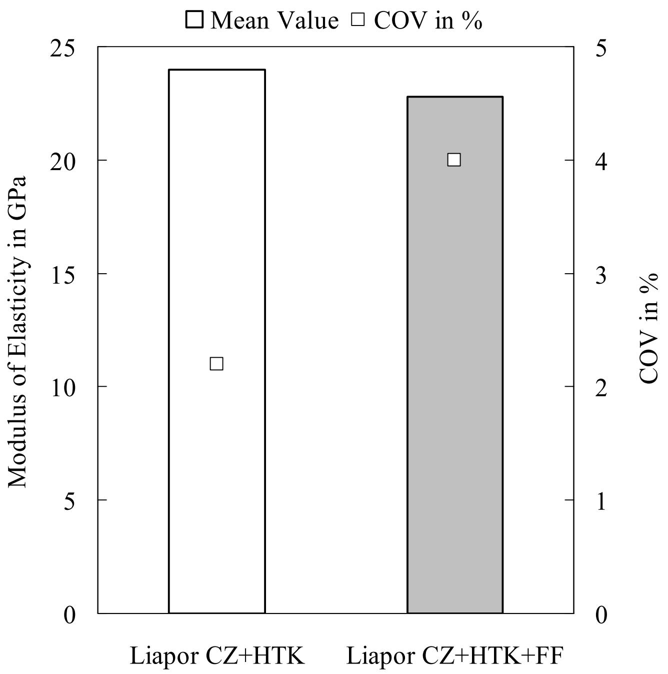

Fig. 3 Mean values of modulus of elasticity in compression: Mean values and coefficients of variation

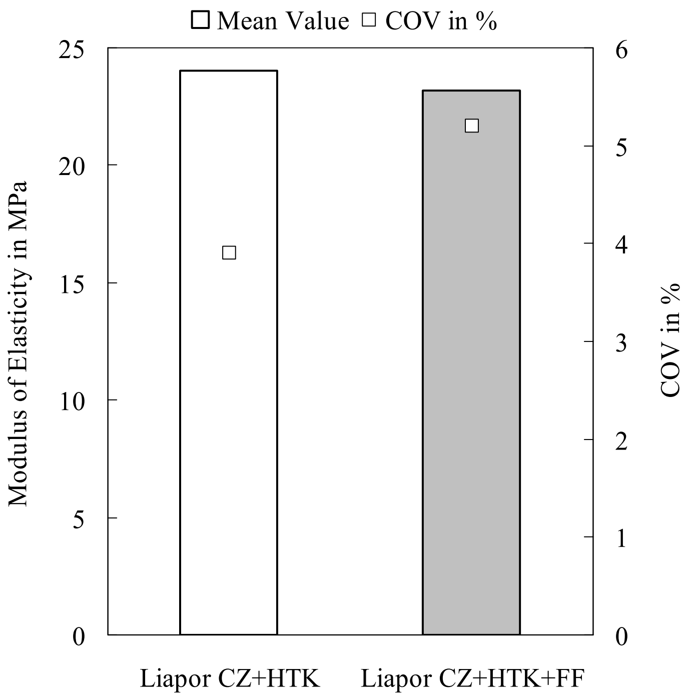

Fig. 4 Mean values of modulus of elasticity in flexure: Mean values and coefficients of variation

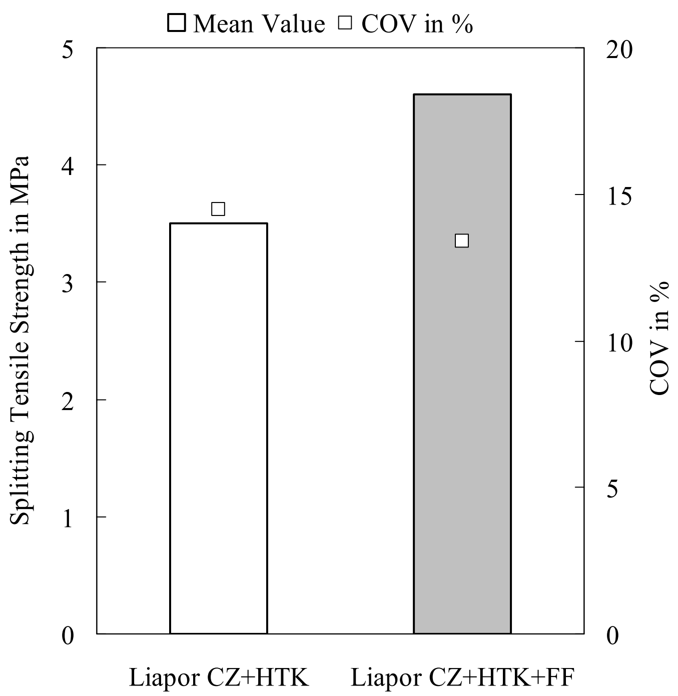

Fig. 5 Mean values of splitting tensile strength: Mean values and coefficients of variation

4 Conclusions

From above presented results it is evident that the fibres addition has no significant effects on the magnitudes tested – the fibres did not affect the origin structure of lightweight concrete (LWC).

The fibres had neither influence on the volume density nor on the compression strength and modulus of elasticity both in compression and in flexure of the resulting composite (Table 1, Fig. 1, 2, 3 and 4). Structural polypropylene fibres have also no significant effect on the behaviour of concrete until the moment bending strength is reached and even then they do not enlarge this strength.

Their function was more convincingly demonstrated during the test of splitting tensile strength carried out on the prism fragments, where the strength of fibre-concretes increased (Fig. 5).

Aknowledgements

This paper was prepared under the support of a grants GA ČR Nr. 103/05/2683 and Nr. 103/06/0685 and research projects MSM 0021630511 and 1M06005.

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