Effect of a Plasticizer and Micronized Stone Powder on Mechanical Properties of a Cement Matrix

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Abstract: The goal of this presented paper was to design a matrix based on cement. This matrix will be reinforced by different types of fibers or microfibers (e.g. on glass, polymeric or steel bases). The effect of a different composition on a flow test and macro mechanical properties as the compressive and bending strength and the dynamic Young's Modulus were tested. Two different types of additives/admixtures were tested – namely a plasticizer and a marble powder. Portland cement CEM I 42.5 R (Mokrá), natural quartz sand from Zálezlice (with fraction of 0-2.0 mm), a commercial plasticizer on a naphthalene base and a marble powder from West bank of Jordan (with fraction of 0-0.125 mm) were used for preparing of tested samples. The samples were tested after 28 days of their preparing.

Keywords: micronized stone powder; plasticizer admixtures; cement; mechanical properties; cement mortars.

1 Introduction

Glass, polymer and rock fibers have a low surface wettability with matrix (e.g. cement, lime or gypsum bases). Adhesion between the fiber surface and the matrix is problematic. Nowadays some different methods are used for modification of fiber surfaces, these ones are based on chemical or mechanical treatment [1]. Plasma treatment of fiber surfaces is newly used too [2]. Conditions of fibers and matrix adhesion depend on quality of the used matrix. Mechanical properties depend on a matrix composition – especially quality and amount of cement, a water/cement ratio and size distribution. E.g. added micronized stone powder or recycled concrete improves a workability of fresh mixtures [3, 4].

2 Materials and Specimens

Composition of designed cement matrixes (amount of components, water and the plasticizer) is shown in Table 1. Six samples for each material were prepared with dimensions of 40 × 40 × 160 mm. The first ones, which was used as reference, consist only of cement and sand (without additions), this set was denoted as (S) for sand. Two tested sets were modified by a plasticizer for reduction of the water/gypsum ratio, these sets were demoted as (P) for the plasticizer. One quarter of sand amount was replaced by a marble powder for other ones, these ones were denoted as (M) for a marble powder. Portland cement CEM I 42.5 R (Mokrá, Czech Republic), natural quartz sand from Zálezlice (Czech Republic) with fraction of 0-2.0 mm, a commercial plasticizer on a naphthalene base and a marble powder from West bank of Jordan (with fraction of 0-0.125 mm) were used for preparing of the tested samples. The marble powder was modified by grinding of waste material from a marble mine. For grinding the high speed mill from LAVARIS Ltd. (Czech Republic) was used.

Tab. 1: Composition of the tested cement matrixes.

Material [mm]	Cement CEM I 42.5R [g]	Sand (0-2 mm) [g]	Marble powder (0-0.125 mm) [g]	Plasticizer [g]	Water/cement ratio [-]
S	210	750	-	-	0.70
S-P	210	750	-	3.15	0.62
S-M	210	562	188	-	0.70
S-M-P	0.15	562	188	3.15	0.60

3 Experimental Methods and Results

The samples were tested after 28 days of their preparing. As a comparative test was used a flow test, value of the slow test was experimentally determined for 10 impulses of 105 ± 5 and 125 ± 5 mm, respectively 20 impulses of 145 ± 5 and 185 ± 5 mm (Tab. 2). A water/cement ratio (Tab. 1) was adjusted for these values. The compressive and bending strengths were determined from standard destructive tests, while the values of the Young's modulus were determined using one of resonance methods, concretely the impulse method. The compressive strength were determined on the 28 days old samples using the Heckert device, model FP100. The testing was displacement controlled at a constant rate of 0.1 mm/s in the case of three-point bending and 0.3 mm/s in compressive. The standard compressive test was performed after the bending test on the broken specimens (half of the samples) with effective dimensions of compressive area of 40 × 40 mm [5]. Measurement of dynamic modulus of elasticity was carried out on the assembly from Brüel & Kjær, basic principles of the impulse method are spelled out in e.g. Lidmila et al. and Padevěd et al. [6, 7]. Obtained experimental results, the flow test and bulk density, are summarized in Table 2. From the results it is clearly visible that the effect of the marble powder is more appreciable.

Tab. 2: Comparison of experimental results (with standard deviations).

Material	Flow test [cm]	Bulk density [kg/m^3]
S	14.6 ± 2.1	1989 ± 15
S-P	14.7 ± 3.1	1999 ±12
S-M	18.7 ± 2.5	2069 ± 25
S-M-P	18.4 ± 2.7	2123 ± 17

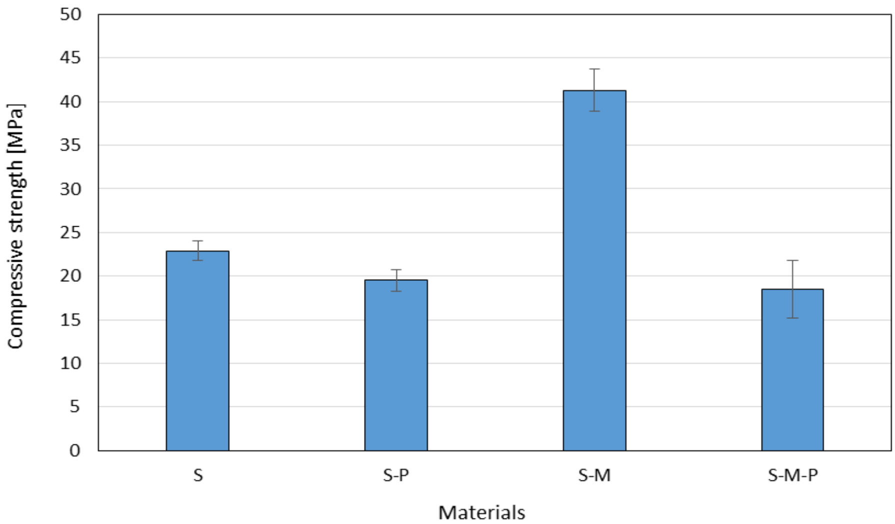

Fig. 1: Comparison of the compressive strength (with standard deviations).

The comparison of the compressive strengths and bending strengths shows Fig. 1, respective Fig. 2. The dependence between the Dynamic Young's Modulus on the bulk density shows Fig. 3. The positive effects of micronized marble powder are clearly visible from all obtained experimental results.

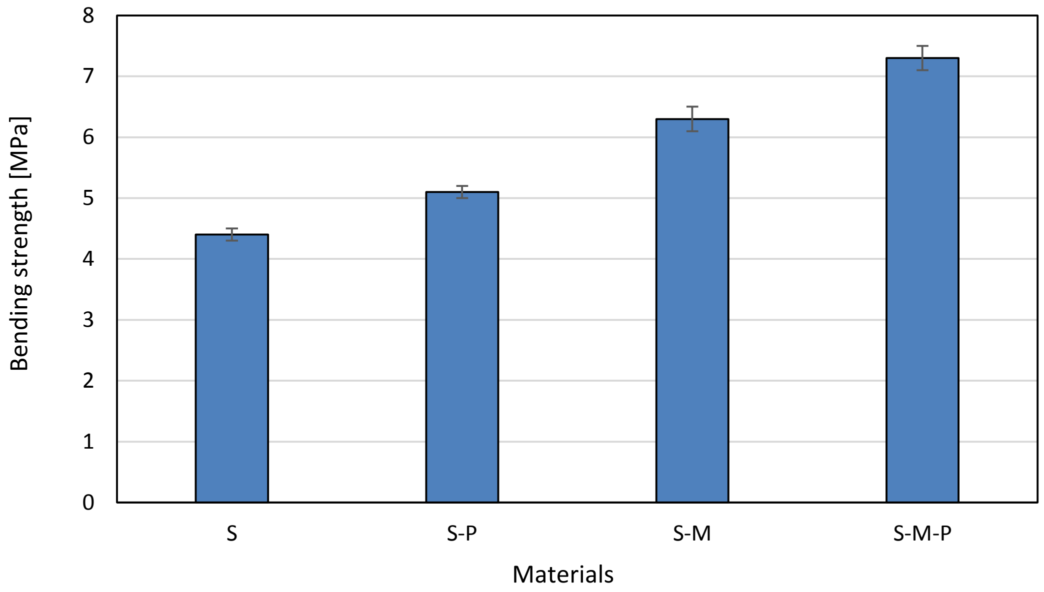

Fig. 2: Comparison of the bending strength (with standard deviations).

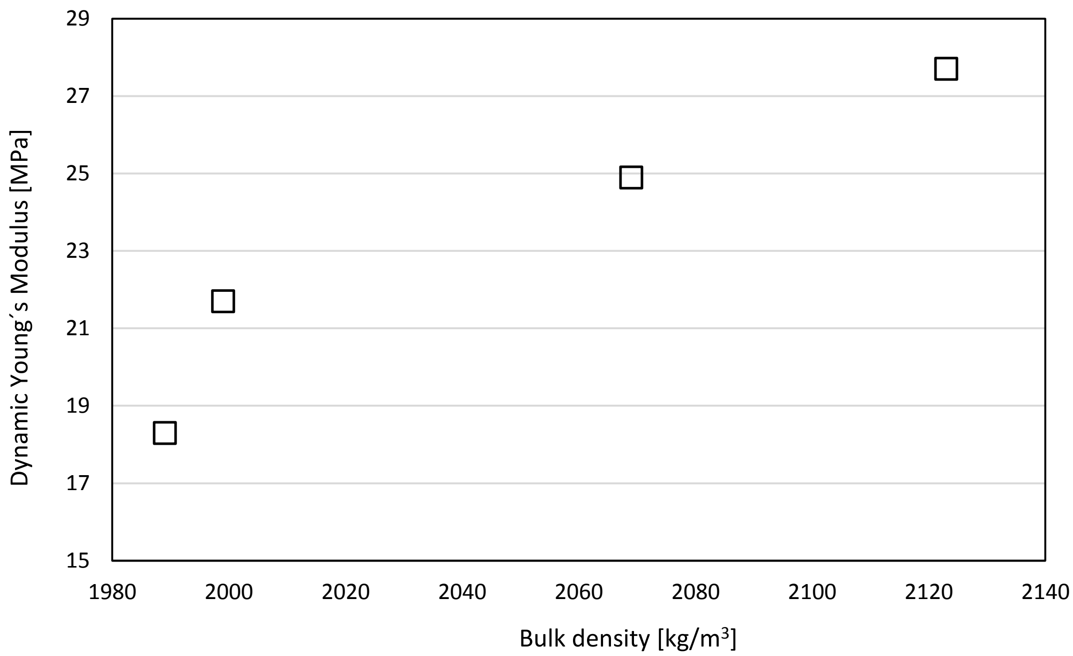

Fig. 3: Dependence of the Dynamic Young's Modulus on the bulk density.

4 Conclusion

The cement matrixes with added micronized marble powder were prepared and tested. From the view point of workability and mechanical properties, this solution was chosen instead of using plasticizers, on the other hand only one plasticizer was tested. Recycled materials are alternative for standard used ones [8, 9]. For the future work this matrix will be reinforced by different types of fibers and microfibers with various types of surface treatments [10].

Acknowledgement

This was financially supported by Czech Technical University in Prague – SGS project SGS16/201/OHK1/3T/11 and by the Czech Science Foundation research project 15-12420S. The authors also thank the Center for Nanotechnology in Civil Engineering at the Faculty of Civil Engineering CTU in Prague and the Joint Laboratory of Polymer Nanofiber Technologies of the Institute of Physics Academy of Science of the Czech Republic and the Faculty of Civil Engineering CTU in Prague.

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