Construction Materials

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Time flow of gypsumfree cements strength development

Jiri Brozovsky[1], Petr Martinec[2] and Jiri Brozovsky, jr[3]
[1,2]*Institute of Building Materials and Components, B.U.T., 602 00, Brno, Czech Republic*
[3]*Department of Building Mechanics, VSB-T.U.O., 708 33 Ostrava, Czech Republic*

Summary

In the paper the results of the investigation of the long – term growth of the strength of gypsumfree cements are presented. It was found that the compression strength exhibits a continuously rising tendency, even though the strength increases with time are small. The tensile bending strengths of gypsumfree cements attain their maxima at the age of 3 and 7 days, respectively and then continuously decrease.

KEYWORDS: gypsumfree cement, strength, long – term strengths, tensile bending strength, compressive strength

1. INTRODUCTION

The solution of this complex of problems is not an end in itself, because the results of tests on gypsumfree cements carried out not only by the author, but also in other organizations e.g. (UD Brno, CVUT Prague, BUT Brno, VUPS Ostrava) have proved that with time there occurs, in certain cases, a decrease of the tensile bending strengths. So far none has been systematically investigating this problem. This is given by the fact that in practical everyday civil engineering compression strength is mostly used as the rating of carriageways.

2. INVESTIGATION OF THE DEVELOPMENT OF GYPSUMFREE CEMENTS STRENGTHS ON PASTES AND STANDARD MORTAR

For the monitoring of long – term strengths of gypsumfree cements have been carried out tests of two gypsumfree cements Prachovice with different admixture contents of the setting regulation system. This was carried out on one hand on test specimens prepared from cement paste, on the other hand on test specimens prepared from standard mortar. In order to eliminate the influence of the specimen

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size onto the results of the tests have been uniformly used standard test specimen with dimensions 0,04 x 0,04 x 0,16m.

The results of the tests of strengths and specific weights of the cement paste and standard mortar are presented in Table 1.

Table 1. Results of strength tests on gypsumfree cements for cement paste and standard mortar

KORTAN FN [% weight]		0,5		0,6	
Na_2CO_3 [% weight]		1,8		1,8	
TYPE OF MIX		CEMENT PASTE w = 0,24	STANDARD MORTAR w = 0,33	CEMENT PASTE w = 0,24	STANDARD MORTAR w = 0,33
tensile bending strength σ_{po} [N/mm]	1 day	11,37	5,13	10,85	5,59
	2 days	12,41	8,27	11,31	8,55
	3 days	13,79	9,28	13,26	10,20
	7 days	14,59	10,44	14,13	11,98
	28 days	13,55	10,39	13,13	11,29
comp-ression strength σ_{pd} [N/mm^2]	1 day	55,5	31,0	54,5	32,6
	2 days	58,5	45,6	57,7	42,7
	3 days	60,7	50,2	60,4	46,0
	7 days	69,8	54,0	69,0	56,3
	28 days	76,6	63,0	75,8	65,1
density D [kg/m^3]	1 day	2 245	2 317	2 237	2 317
	2 days	2 250	2 326	2 249	2 332
	3 days	2 261	2 331	2 268	2 332
	7 days	2 263	2 338	2 263	2 334
	28 days	2 268	2 343	2 265	2 335
specific weight ρ [kg/m^3]		2 610	2 640	2 540	2 640
		2 520	2 620	2 570	2 650
		2 510	2 640	2570	2 630
	∅	2 547	2 633	2 560	2 640

3. MONITORING THE LONG – TERM GROWTH OF GYPSUMFREE CEMENTS STRENGTHS

For monitoring the long – term growth of gypsumfree cements strengths have been prepared test specimen from standard mortar in such quantities as to allow to follow the development of strengths during a period of at least 3 years – for every age 9 test specimens were tested.

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For the tests was employed gypsumfree cement prepared from MALOMERICE clinker ground to a specific surface 632 m^2kg^{-1} which contained 0,5% Ligrasol and 0,7% referred to the weight of the clinker.

Two types of cement have been tested:

- sample R1 – without supplementary admixtures
- sample R1 – with a supplementary quantity of Na_2CO_3 – 1,2% weight from the clinker weight.

The following parameters have been determined:

- tensile bending strength
- compression strength
- propagation rate of ultrasonic pulses in cements at an age of 1, 2, 3, 7, 28 days and 1, 2, 3, years.

The sample has been stored for entire period in a standard environment, i.e. in the form of water storage. The results of the tests are presented in table 2 and graphically illustrated in figure 1 and 2.

Table 2. Results of strength tests and measurements of ultrasonic pulses propagation rates for various age of gypsumfree cements

Gypsumfree cement clinker Malomerice 632 m^2kg^{-1} 0,5%LIGRASOL + 0,7% Na_2CO_3		without supplementary admixtures	+ 1,2 % Na_2C0_3 referred to clinker weight
tensile bending strength σ_{po} [N/mm^2]	1 day	5,96	8,37
	2 days	10,37	9,46
	3 days	13,39	12,30
	7 days	13,81	12,52
	28 days	12,96	11,75
	1 year	11,57	10,11
	2years	11,02	9,66
	3 years	10,39	8,84
compression strength σ_{pd} [N/mm^2]	1 day	38,7	46,3
	2 days	55,2	53,1
	3 days	58,4	55,4
	7 days	63,1	60,4
	28 days	70,9	68,7
	1 year	88,0	85,1
	2years	88,8	87,2
	3 years	90,5	95,1

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Gypsumfree cement clinker Malomerice 632 m^2kg^{-1} 0,5%LIGRASOL + 0,7% Na_2CO_3		without supplementary admixtures	+ 1,2 % Na_2C0_3 referred to clinker weight
ultrasonic pulse velocity V[m/s]	1 day	4 414	4 679
	2 days	4 635	------
	3 days	-----	4 767
	7 days	-----	------
	28 days	4903	4 880
	1 year	4 962	4 942
	2years	4 975	4 949
	3 years	4 990	4 967

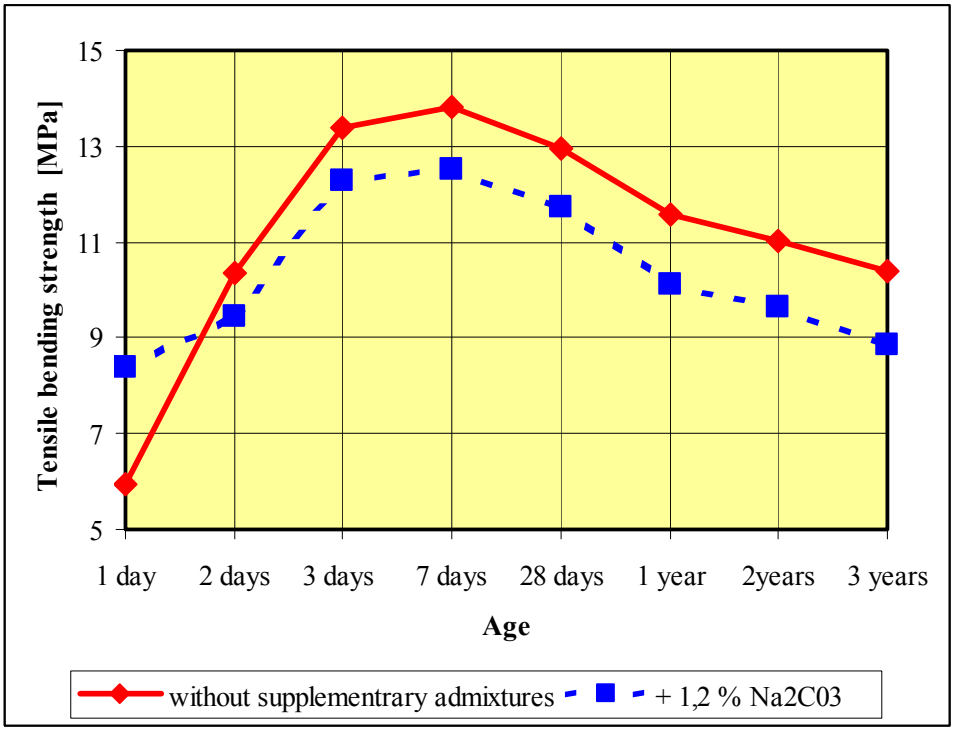

Figure 1. Long-term tensile bending strength of gypsumfree cements in relation to time

The tensile bending strength of gypsumfree cements attains its maximum at the age 7 days, and then its systematic decrease occurs. For the determination of reasons for this descreares were carried out physical and chemical tests for determining the mineralogical composition of the cements and the microstructure at the age of 3

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years. The sample was in fact subjected to X – ray diffraction analysis and the microstructure was photographed on and electron scanning microscope.

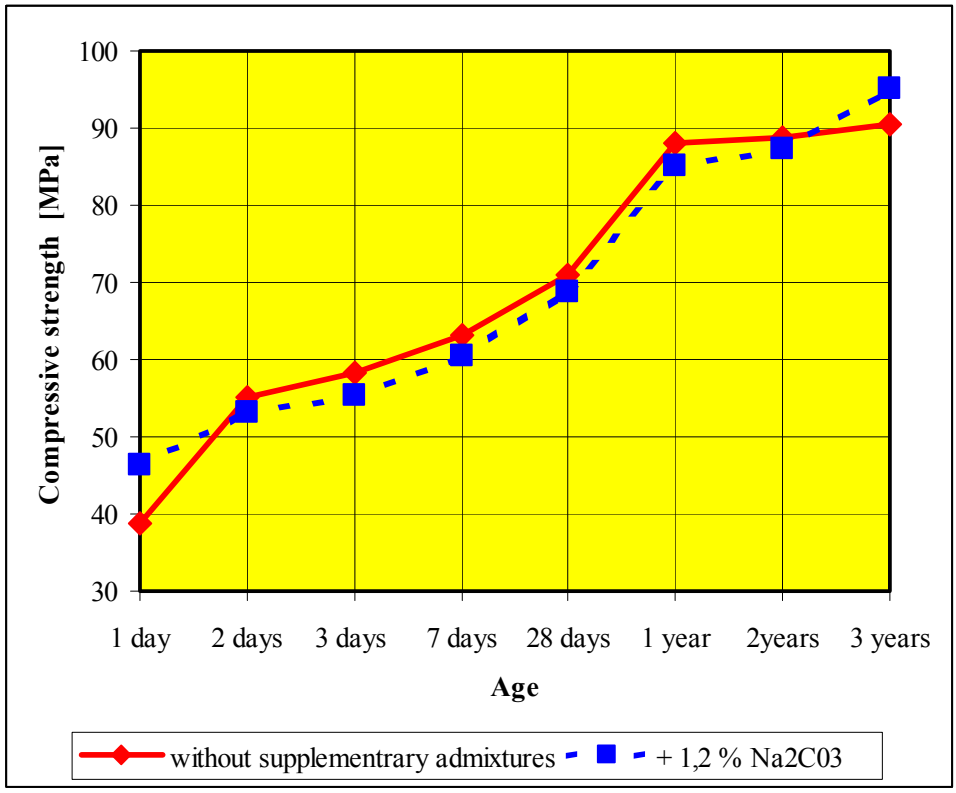

Figure 2. Long-term compressive strength of gypsumfree cements in relation to time

The results of the X – ray diffraction analysis are presented in Table 3.

Table 3. Results of the X – ray diffraction analysis of GFC samples

Marking of sample	Identified minerals
R1 - 1	*quartz, calcite, portlandite, β - C_2S, C_3S, C_4AH_{13}*
R1 - 6	*quartz, calcite, portlandite, β - C_2S, C_3S, C_4AH_{13}*
R2 - 1	*quartz, calcite, portlandite, C_4AH_{13}, muscovite*
R2 - 2	*quartz, calcite, portlandite, C_4AH_{13}, CSH II, clay minerals - traces*

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4. CONCLUSIONS

Long term tests of GFC have shown that the tensile bending strength after the attainment of their maxima after 7 days continuously decrease during next period and at the age 3 years approach the values that have been obtained at the age of 2 and 1 day, respectively.

After one year the growth of the GFC compressive strength is considerably slowed down, but no tendencies to a decrease of these values have been determined.

The determination of the ultrasonic pulse rates in the tested GFC samples exhibits in relation to time a continuously increasing tendency. From this can be concluded that no deterioration of the microstructure by cracks take place.

Studies of the mineralogical composition and the microstructure have also identified no anomalies that could lead to a decrease of the long-term tensile bending strength values.

Acknowledgements

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