SOME PROBLEMS OF PRODUCING AERATED CEMENT OR CONCRETE

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Abstract

A complex testing of aerated cements and aerated concrete and some of the test results are discussed in this article.

Properties of foam cements were tested on several cements. Tests showed that strength depends on the quality and quantity of components and mainly on the size of pores which is the result of the production technology.

A continuous test program shows that the development of aerated concrete/cement satisfies the requirements of current constructions.

1. Introduction

There is a trend in Hungary to use precast and site cast heat insulator concrete to introduce energy conserving building technologies. The most common of all heat insulator concretes are the aerated cements and aerated concretes with a wide range of parameters. Aerated concrete has been produced in Western Europe and in some of the developing countries for more than a decade. The detailed recipe of aerated concrete and the full description of production technology is usually not available or not fully applicable to the Hungarian binding materials and aggregates. The technology of aerated concrete is a very new Hungarian production and started only a few years ago. Several companies, including the Department of Building Materials, have tried to develop and introduce production technologies.

The research has not yet come to an end but part of the results are worth publishing. Research work at this stage is focusing on finding tendencies and not on evaluating numerical properties.

2. Materials

The following cements from different factories with different ages were used: Beremend 350 FAPC-10, Beremend 450 PC, Bélapátfalva 450 PC and Vác 450 RPC. FOAMIN "C" was the aerating agent. Table 1 summarizes the mineral composition and physical properties of the cements. The Beremend 350 FAPC-10 was a Beremend 450 PC cement plus 10% acidic fly ash added.

Table 1

The Properties of Cements

Components m %	Cements			
	Beremendi 450 p	Bélapátfalvai 450 pc	Váci 450 Rpc	Beremendi 350 ppc 10
AM	1.73	1.57	1.67	
CaO total	60.61	62.36	60.77	
C_3S	49.28	55.20	47.82	
C_2S	21.60	18.81	22.28	
C_3A	9.33	7.03	9.67	
C_4AF	9.79	10.95	10.83	
MgO	2.48	2.01	2.28	
SO_3	3.23	1.94	2.40	
CaO (free)	0.49	0.32	1.50	
loss on burning	1.15	1.32	1.62	
Strength MPa				
Flexural				
1 days	3.72	4.26	3.88	3.06
7 days	6.80	8.61	8.02	3.80
28 days	7.90	8.91	8.17	4.20
Compressive				
1 days	16.4	15.8	17.1	11.6
7 days	35.2	36.7	35.8	25.1
28 days	45.0	47.7	45.3	35.8
Specific surface m^2/kg (Blaine test)	311	407	356	255

The properties of the hydralized protein based FOAMIN "C" are:

- dark brown colour,
- easy foam generating,
- density at 20 °C: 1141 kg/m^3,
- pH: 7.0,
- viscosity (OSTWALD) at 20 °C: 7.5×10^{-3} Pas,
- solid content (dried at 100 °C): 31.0 m%,
- viscosity (DIN-04 mm) at 20 °C: 11.88s,
- sulphate and chloride content: detected in a small quantity.

3. Foams

During the reseach project mainly mechanically produced, airblown foams were tested. FOAMIN "C" (2.5 m%), water and cement were foamed in a Turbofoam. The body density of the foams varied between 38—108 kg/m^3 in relation to the air pressure used. The foams around 75 kg/m^3 body density were found to be the most appropriate for further tests because these foams had the least slump. Mechanical foam beating resulted in heavier foams than airblown ones and smaller pore sizes in the foams.

4. The effects of foaming agent on the properties of concrete

The setting times of the cements were determined according to MSZ 523 (Hungarian Standards). The effects of the foaming agent on setting time was tested of the standard cement paste mixture plus 1 m% foaming agent (by cement mass). There was a cement which became softer when the foaming agent was added, thus the standard cement mixture could have been produced with less water.

As Table 2 indicates, tests show that the foaming agent had a great influence on the setting time of concrete. Although the exact relationship between the added agent and setting time was not discovered, it was found that the amount of setting water was not proportional to the resulting retarding effect. This retarding effect meant that the foaming agent increased the consistency of the cement paste.

Hardening of the cement was tested according to MSZ 523 (Hungarian Standards on strength test of binders) and mortar was mixed using ISO mixer. The initial strength of the binders influenced the consumption of foam cements and foam concretes and thus the strength at 20 hours was always

Table 2

The effect of FOAMIN "C" on setting time

		Setting time					
		start			end		
		hour	min	%	hour	min	%
Beremendi 450 pc	standard cementpaste	2	35	100	5	20	100
	paste + foaming agent	6	20	217	9	0	169
Beremendi 350 ppc-10	standard cementpaste	6	25	100	5	0	100
	paste + foaming agent	6	50	200	10	0	200
Bélapátfalvai 450 pc	standard cementpaste	3	20	100	4	30	100
	paste + foaming agent	5	0	150	5	50	130
Váci 450 Rpc	standard cementpaste	2	10	100	3	15	100
	paste + foaming agent	3	45	173	4	40	144

measured. During the evaluation the effects of the foaming agent were compared to those samples which were made without the agent. It is stated, according to Table 3, that adding 1% foaming agent results in

20—34% lighter body density,
0 —67% lower flexure strength and
23—77% lower compressive strength.

The largest decrease of the tested properties was observed on the Beremend 350 FAPC — 10 mixture.

Table 3

Strength of 20 hours aerated mortars

Cement	Components	Storing	Average body density kg/m³	%	Average strength flexural N/mm²	tensile %	compressive N/mm²	%
Beremendi 450 pc	mortar	free air	2133	100	1.42	100	4.49	100
	mortar + foaming agent	free air	1709	80	0.89	63	2.12	47
	mortar + foaming agent	steam	1583	74	1.48	104	1.46	77
Beremendi 350 pp-10	mortar	free air	2164	100	0.98	100	3.47	100
	mortar +foaming agent	free air	1504	70	0.32	33	0.80	23
	mortar + foaming agent	steam	1437	66	0.74	76	1.38	40
Bélapátfalvai 450 pc	mortar	free air	2150	100	1.79	100	4.75	100
	mortar + foaming agent	free air	1663	77	1.15	64	2.18	46
Váci 450 Rpc	mortar	free air	2117	100	1.39	100	4.59	100
	mortar + foaming agent	free air	1628	77	0.56	40	1.69	36
	mortar + foaming agent	steam	1484	70	0.94	68	2.10	48

5. The properties of aerated cements

The strength properties of airblown cement pastes with 1.5—3.0 mm pores diameter are shown in Figures 1—3 and the strength properties of the airblown, mechanically beaten micropore foam cements are shown in relation to the body density on Figures 4 and 5. For comparison the strength properties of NEOPOR foam cements are available in the bibliography. On Figure 6 the thermal conductivity of aerated cements, measured with the Bock device at

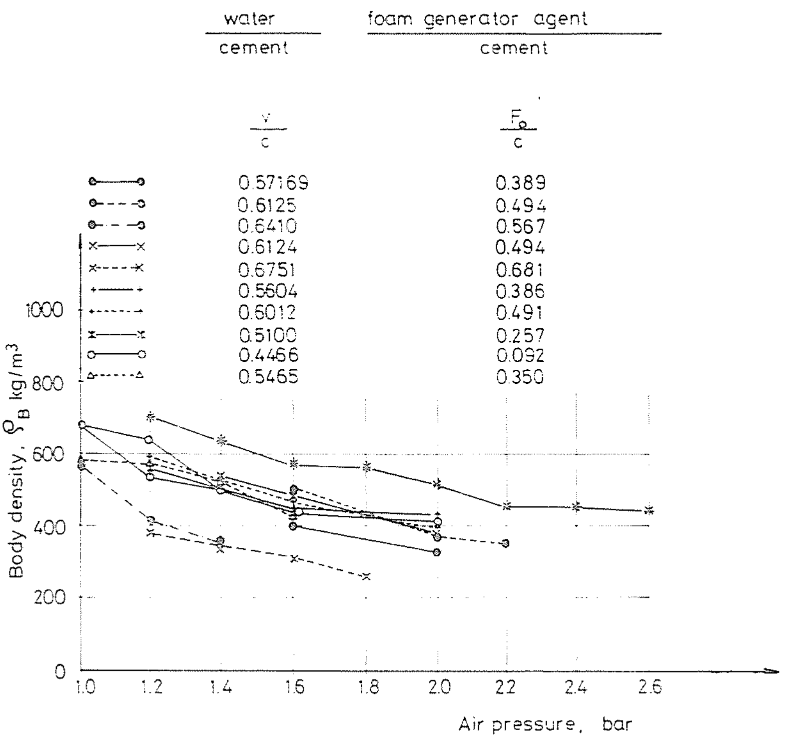

Fig. 1. Changing the body density of airblown fresh aerated cement with air pressure

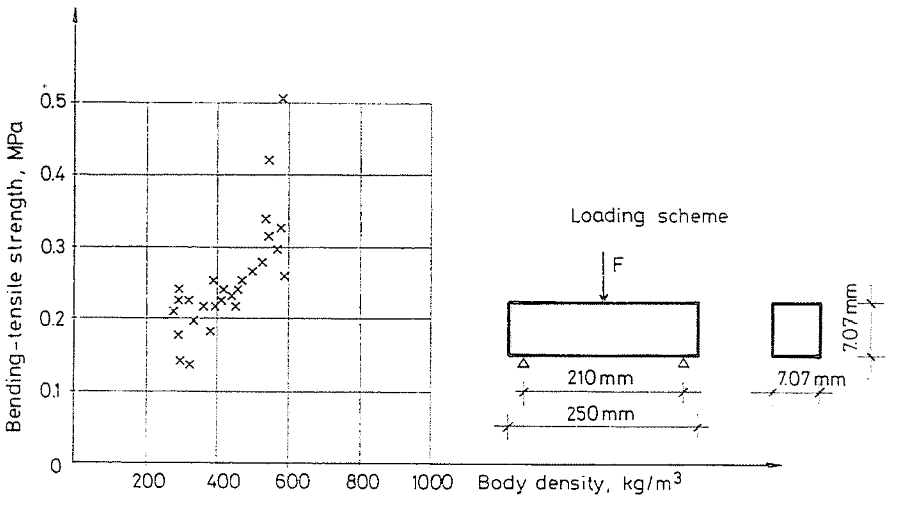

Fig. 2. The flexure strength of airblown, dry VAC 450 RPC aerated cement related to the body (sample ages were 28 days or older)

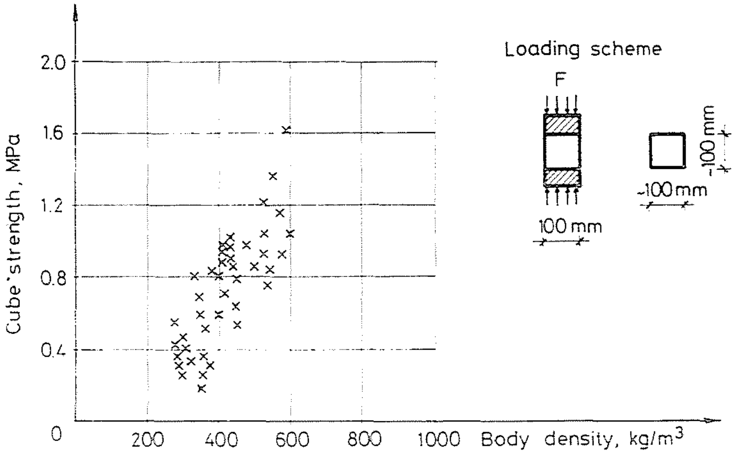

Fig. 3. The compressive strength of airblown, dry VAC 450 RPC aerated concrete related to the body density (more than 28 days)

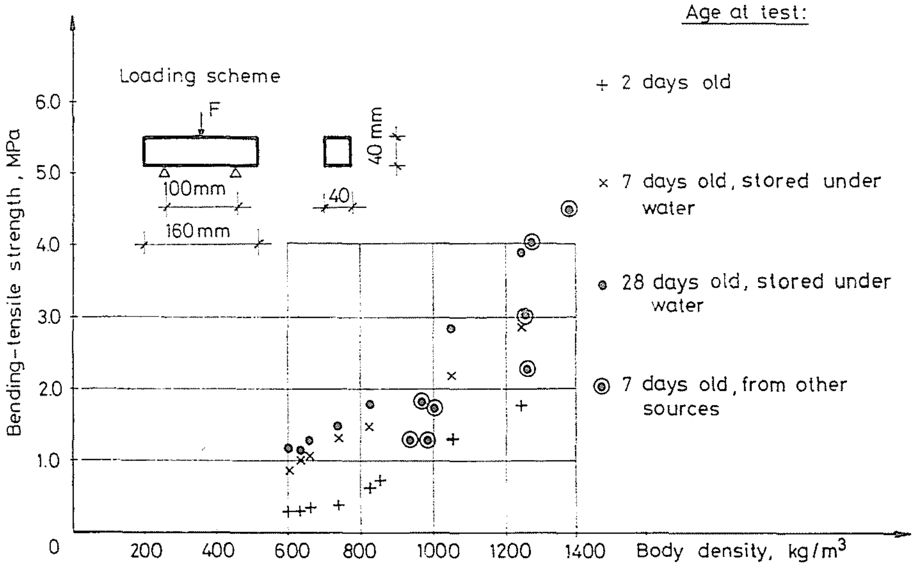

Fig. 4. Flexure strength of airblown and beated FOAMIN "C" aerated cements

25 °C temperature, is compared to the thermal conductivity of NEOPOR foam concrete.

The summarized test results indicate that the strength of aerated cement and concrete depends on the production technology. Airblown foams are

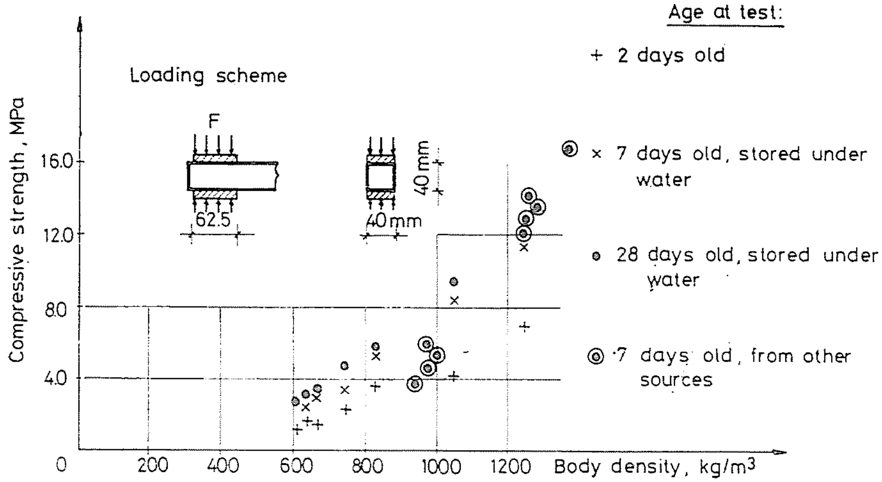

Fig. 5. Compressive strength of airblown and beaten FOAMIN "C" aerated cements

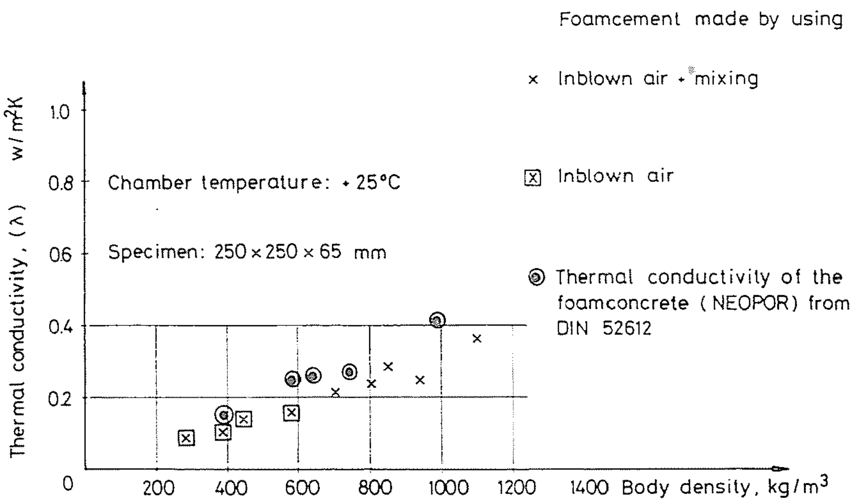

Fig. 6. The thermal conductivity of FOAMIN "C" aerated cements related to the body density (more than 28 days)

lighter with larger pores and have lower strength compared to mechanically beaten foams. The thermal conductivity of the foams is less sensitive on the production technology than on all the other properties of foam cements.

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