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United States Patent [19][11] **Patent Number:** 5,087,287**Hihara et al.**[45] **Date of Patent:** Feb. 11, 1992[54] **STRENGTHENED CELLULAR CONCRETE COMPOSITIONS AND METHOD OF MAKING**[75] **Inventors:** Mikio Hihara; Nobuhisa Suzuki, both of Fuji, Japan[73] **Assignee:** Nissei Plan, Inc., Sizuoka, Japan[21] **Appl. No.:** 234,951[22] **Filed:** Aug. 22, 1988[30] **Foreign Application Priority Data**

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[51] **Int. Cl.⁵** C04B 7/00[52] **U.S. Cl.** 106/677; 106/696; 106/728; 106/823[58] **Field of Search** 106/88, 162, 677, 689, 106/696, 728, 823, 605, 608[56] **References Cited****U.S. PATENT DOCUMENTS**

2,478,831	8/1949	MacPherson	106/88
3,563,777	2/1971	Pratt et al.	106/88
3,758,319	9/1973	Ergene	106/88
4,057,608	11/1977	Hashimoto et al.	106/88
4,204,877	5/1980	Moorer et al.	106/315
4,209,336	6/1980	Previte	106/93
4,325,736	4/1982	Okada et al.	521/83
4,655,979	4/1987	Nakano et al.	106/88

4,662,942	5/1987	Koga et al.	524/5
4,668,295	5/1987	Bajpai	524/5
4,906,298	3/1990	Natsuume et al.	524/5

FOREIGN PATENT DOCUMENTS

145394	7/1949	Australia	106/88
628725	10/1961	Canada	106/88
1331922	10/1961	France	106/88
153203	9/1964	U.S.S.R.	106/88
2218977	11/1989	United Kingdom	
01499	4/1985	World Int. Prop. O.	106/88
01500	4/1985	World Int. Prop. O.	106/88

Primary Examiner—Olik Chaudhuri*Assistant Examiner*—Andrew Griffis*Attorney, Agent, or Firm*—Wenderoth, Lind & Ponack[57] **ABSTRACT**

A cellular concrete composition having improved strength consisting of hydraulic cement, water and at least one alpha, beta-unsaturated dicarboxylic acid such as maleic or fumaric acid. A method is also provided comprising preparing a cement paste containing hydraulic cement and water, mixing the cement paste with a bubbled frother solution containing at least one alpha, beta-unsaturated dicarboxylic acid and optionally an alkylene glycol and/or a nonionic surface-active agent, and casting the mixture in a mold to solidify.

10 Claims, No Drawings

STRENGTHENED CELLULAR CONCRETE COMPOSITIONS AND METHOD OF MAKING

BACKGROUND OF THE INVENTION

The present invention relates to cellular concrete compositions which are strengthened by addition of polycarboxylic acids, and the method of making such compositions. More particularly the present invention relates to light-weight cellular concrete, the strength of which is improved by addition of polycarboxylic acids such as maleic and fumaric acid or their combined use with alkylene glycols such as ethylene glycol and/or nonionic surface active agents such as polyethylene glycol, and the method, in which cellular concrete is produced by mixing a cement mortar or paste with a bubbled frother solution containing polycarboxylic acids or together with alkylene glycols and/or nonionic surface active agents.

The light weight, heat insulation, fire resistance, and sound insulation of cellular concrete have allowed it to find a definite niche in the field of building materials.

The process for producing cellular concrete is generally divided into two: (1) to make a cement mortar foam in a form after mixing all the ingredients and (2) to mix a cement paste with a bubbled frother solution, followed by casting this cellular concrete paste into a form. The latter method is widely used since it can make it easy to manufacture the desired form of cellular concrete. However, this procedure has a difficulty to control the flow of aerated concrete slurry or to cause defoaming during the mixing.

For this reason, the use of surface active agents or decomposition products of keratin-type proteins as frother have been proposed. And also, Japanese Patent Publication No. 61-5673 provides processes in which cellular concrete is produced by addition of anionic surface active agents during or just after mixing a cement mortar with a bubbled, high-viscous frother solution. These methods, however, are also unsatisfactory since they do not give cellular concrete manufactures having a sufficient mechanical strength.

SUMMARY OF THE INVENTION

In accordance with the present invention, cellular concrete compositions are provided that are strengthened by addition of polycarboxylic acids such as maleic and fumaric acid or their combined use with alkylene glycol and/or nonionic surface-active agents such as polyethylene glycol, and methods of making such compositions, with excellent properties, as compared with the conventional frothers or methods which are provided by Japanese Patent Publication No. 61-5673.

Exemplary polycarboxylic acids include maleic acid, fumaric acid, itaconic acid, succinic acid, oxalic acid, tartaric acid, sebacic acid, malonic acid, phthalic acid, terephthalic acid, trimellitic acid, and pyromellitic acid. Exemplary alkylene glycols include ethylene glycol, propylene glycol, and butylene glycol. Exemplary nonionic surface-active agents include polyethylene glycol, polyethylene glycol alkyl ether, polypropylene alkyl ether, polyethylene glycol fatty acid ester, sorbitan fatty acid ester, and fatty acid monoglyceride.

Cellular concrete compositions of the present invention are manufactured by mixing a cement paste with a bubbled frother solution containing polycarboxylic

acids or together with alkylene glycols and/or nonionic surface active agents.

In this case, aggregates such as sand and silica may be used in combination with cement. And also, hydraulic cement such as Portland or alumina cement is commonly used.

In addition, other conventional additives for cellular concrete, such as thickeners, water reducing agents, other surface active agents, and binders can be employed.

The following Examples are illustrative.

EXAMPLE 1

Production of cellular concrete manufacture containing maleic and fumaric acid and ethylene glycol

Into 3600 g of Portland cement (Nippon Cement) was added 2000 ml of water and the mixture was agitated to form a cement paste. In the meantime, 5 g of maleic acid and 3 g of fumaric acid and 2 g of ethylene glycol were dissolved in 190 ml of water. The mixture was aerated by a bubble generator, to form a frother solution. The above cement paste and frother solution were mixed and agitated to form a cellular concrete slurry. The slurry was casted into a form. The concrete in the form was allowed to stand for 28 days at room temperature. The resultant cellular concrete manufacture was taken out from the form and cut in the form of $4 \times 4 \times 16$ cm³ plate. The found specific gravity of the product was 0.58, giving an indication that the content of blowhole was 66.5 vol %.

The following examples represent preferred embodiments of cellular concrete compositions in accordance with the invention.

EXAMPLE 2

Cellular concrete compositions were prepared using frothers of the invention and two of the prior art, and having the following formulation:

Ingredients	Parts by Weight
Portland cement (Nippon Cement)	3600
Water	2190 (2000 ml for cement paste and 190 ml for frother solution)
Frother	10

TABLE 1

Example No.	Frother
Control 1	Polyvalent metal salt of synthetic high polymer (Pafoam EPM-I, Kao Sekken)
Control 2	Decomposition product of Keratin-type protein (Foamix CII: Hamano Kogyo)
Example 1	maleic acid
Example 2	maleic acid and fumaric acid (7:3 by weight)
Example 3	maleic acid and fumaric acid and ethylene glycol (5:3:2 by weight)
Example 4	maleic acid and fumaric acid and polyethylene glycol (5:3:2 by weight)
Example 5	maleic acid and fumaric acid and ethylene glycol and polyethylene glycol (5:3:1:1 by weight)

Cellular concrete manufactures containing frothers shown in Table 1 were produced in the same manner as described in Example 1. The aeration of the frother solution was regulated to make the specific gravity of the final product to be 0.58 ± 0.02 , which corresponds to 66.5 ± 2.3 vol % of blowhole. Plates of $4 \times 4 \times 6$ cm³

were cut off and subjected to mechanical strength tests. The results are shown in Tables 2 and 3.

TABLE 2

Example NO.	Compressive strength (kg/cm ²)	Coefficient of contraction (× 10 ⁻⁴)
Control 1	16	18
Control 2	16	18
Example 1	20	13
Example 2	21	12
Example 3	22	11
Example 4	22	11
Example 5	23	10

TABLE 3

Example No.	Young's modulus (× 10 ⁻⁴)	flexural strength (kg/cm ²)
Control 1	0.8	1
Control 2	0.8	2
Example 1	1.4	3
Example 2	1.4	4
Example 3	1.5	4
Example 4	1.5	4
Example 5	1.6	5

The improvement when using the frother of the invention as compared with the Controls is evident from the above data.

Since many embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific examples except to the defined in the following claims.

What is claimed is:

1. A cellular concrete composition having improved mechanical strength consisting essentially of hydraulic cement, water and at least one alpha,beta-unsaturated dicarboxylic acid.

2. A strengthened cellular concrete composition according to claim 1 in which the alpha,beta-unsaturated dicarboxylic acid is maleic acid.

3. A strengthened cellular concrete composition according to claim 1 in which the alpha,beta-unsaturated dicarboxylic acids are maleic acid and fumaric acid.

4. A strengthened cellular concrete composition according to claim 1 in which the composition further contains an alkylene glycol.

5. A strengthened cellular concrete composition according to claim 4 in which the alkylene glycol is ethylene glycol.

6. A strengthened cellular concrete composition according to claim 1 in which the composition contains a nonionic surface-active agent.

7. A strengthened cellular concrete composition according to claim 6 in which the nonionic surface-active agent is polyethylene glycol.

8. A strengthened cellular concrete composition according to claim 1 in which the composition contains an alkylene glycol and a nonionic surface-active agent.

9. A strengthened cellular concrete composition according to claim 8 in which the alkylene glycol is ethylene glycol, and the nonionic surface-active agent is polyethylene glycol.

10. A strengthened cellular concrete composition according to claim 1 in which the hydraulic cement is Portland cement.

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