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(54) Title: ADMIXTURE FOR CEMENTITIOUS COMPOSITIONS

(57) Abstract: An admixture for cementitious compositions for imparting water repellant properties to the cementitious composition. The admixture comprises a polymer, a surfactant, and a hydrophobic material that is an organic ester of an aliphatic carboxylic acid. Also, a cementitious composition comprising cement, a polymer, a surfactant, and a hydrophobic material that is an organic ester of an aliphatic carboxylic acid. Also, a method of forming a cementitious composition comprising mixing a cement, a polymer, a hydrophobic material, a surfactant, and water.

ADMIXTURE FOR CEMENTITIOUS COMPOSITIONS

FIELD OF THE INVENTION

The present invention is directed to an admixture for cementitious compositions. More particularly, the present invention is directed to an admixture that imparts water repellent properties to cementitious compositions.

BACKGROUND OF THE INVENTION

"Cementitious mixture" refers to pastes, mortars, and concrete compositions comprising a hydraulic cement binder having consistencies ranging from stiff to extremely dry as defined in ACI 211.3R, Table 2.3.1. Pastes are defined as mixtures composed of a hydraulic cement binder, either alone or in combination with pozzolans such as fly ash, silica fume, or blast furnace slag, and water. Mortars are defined as pastes that additionally include fine aggregate. Concretes additionally include coarse aggregate. These compositions may additionally include other admixtures such as set retarders, set accelerators, defoaming agents, air-entraining or air-detraining agents, corrosion inhibitors, water-reducing agents, pigments, and any other admixture that does not adversely affect the advantageous results obtained by the admixtures of the present invention.

Cementitious cast mixtures are used to form many articles, for example, concrete pipe, roof tile, masonry units, paver units, extruded plank, and any other preformed cementitious articles, in a mould or from an extrusion die. Each of these applications has basic desired characteristics that are critical in terms of producing quality finished units.

In masonry block applications, production speed, sufficient green strength, and the ability to resist slumping, sagging or deforming when stripped from the mould is critical since stripping occurs immediately after casting. The same is true for concrete pipe or roof tile with the additional desired property of improved surface appearance with reduced surface imperfections and reduced roller and/or die wear on equipment producing extruded pieces.

It is desired to reduce the cycle time of the manufacture of each article. The reduction of cycle time reduces the cost of manufacture for each article and increases the number of articles that can be produced in a given time. Cycle time is defined as the time to complete one full cycle from the beginning of feed to the end, or next beginning of feed. The beginning of feed is when the cast mixture is fed from a collection hopper into the process. It is also desired to improve the compaction and consolidation of the cementitious cast mixture without altering the consistency of the mixture.

Green strength refers to the stability of the article in retaining its shape once the article is removed from the mould or extruder. Green strength is dependent on the consistency of the cementitious cast mixture, the amount of fines in the cementitious cast mixture, and the mouldability of the cementitious cast mixture.

Currently, the water to cement (W/C) ratio used in cast mixtures is from about 0.25 to about 0.60. It is desired to minimize the amount of water needed in a cementitious cast mixture to achieve consolidation and no sag or deformation in an article produced from the cementitious cast mixture.

Another property of cementitious cast mixtures for certain cast industries is swipe. Swipe is defined as surface effect on a cast article when the mould is removed. Swipe is measured by visually evaluating the surface of the finished article. Swipe is ranked from no swipe to heavy swipe. It is desired to achieve a selected amount of swipe for a finished article.

A further limitation in the present art is the compressive strength of articles produced from cementitious mixtures. Early compressive strength is defined as the compressive strength achieved within 24 hours with or without steam cure. Compressive strength is determined by ASTM C-1176-2.

Another limitation is water permeation through the finished cementitious article. When a cementitious article becomes wetted, such as by direct contact or from rain, water can penetrate the article. This occurs because cementitious articles are porous. The water can make the article appear unsightly, and bacteria or fungus can then grow on the damp article. Typically, a water repellant material has to be applied to a finished cementitious article to protect the article from water penetration. This requires additional steps and costs.

What is needed in the art is an admixture that can be directly added to a cementitious mixture to provide water-repellant properties and to increase the compressive strength of a formed cementitious article. What is also needed in the art is a reduction in cycle time for the formation of a cementitious cast article.

SUMMARY OF THE INVENTION

The present invention provides an admixture for cementitious compositions comprising a polymer, a surfactant, and a hydrophobic material that is an organic ester of an aliphatic carboxylic acid.

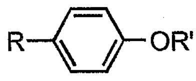
The present invention also provides a cementitious composition comprising cement, a polymer, a surfactant, and a hydrophobic material that is an organic ester of an aliphatic carboxylic acid.

The present invention also provides a method of forming a cementitious composition comprising mixing a cement, a polymer, a hydrophobic material that is an organic ester of an aliphatic carboxylic acid, a surfactant, and water.

DETAILED DESCRIPTION OF THE INVENTION

Preferably, the hydrophobic material is an organic ester of an aliphatic carboxylic acid. Preferably, the organic ester of an aliphatic carboxylic acid is represented by the general formula R_1-R_2, wherein R_1 is C_{12}-C_{18} aliphatic carboxylic acid ester, and R_2 is a linear or branched C_1 to C_{10} alkyl. Preferred aliphatic carboxylic acid esters include, but are not limited to, stearate, oleate, naturally-occurring oils, laurate, palmitate, myristic ester, and linoleic ester. Preferred hydrophobic materials include, but are not limited to, alkyl stearate esters, alkyl oleate esters, and mixtures thereof. Preferably, the organic ester of a stearate has the general formula $C_{17}H_{35}COOR_3$ and the organic ester of an oleate has the general formula $CH_3(CH_2)_7$=$(CH_2)_7COOR_4$, wherein R_3 and R_4 are each independently a linear or branched C_1 to C_{10} alkyl. A preferred stearate is butyl stearate, and a preferred oleate is butyl oleate. Preferred naturally-occurring oils include castor oil and coconut oil.

The polymer of the present invention is preferably a latex polymer. Suitable latex polymers include, but are not limited to, styrene butadiene copolymers, polyacrylate latex, polymethacrylate latex, carboxylated styrene latex, isoprene-styrene copolymer. A preferred latex polymer is a carboxylated styrene butadiene copolymer latex. Generally, the polymer has a number average molecular weight from 500 to 50,000, preferably, from 1,000 to 2,000. A preferred latex polymer is sold under the trade name TYLAC CPS814 from Reichold Chemicals, Inc.

The surfactant can be any surfactant that can emulsify the hydrophobic material. Suitable examples of the surfactant include, but are not limited to, ionic, non-ionic and amphoteric surfactants. Preferably, the surfactant is at least one of an ethoxylated alkyl phenol. Preferably the ethoxylated alkyl phenol has the general structure 

, wherein R=C_1 to C_{20} alkyl, and R'=-$(CH_2CH_2\text{-}O)_n$-, n=1 to 100. A preferred ethoxylated alkyl phenol is ethoxylated nonylphenol, wherein n=8.

Generally, when formulated as an admixture, the polymer is present in the admixture from 0.5% to 20% based on the total weight of the admixture, the hydrophobic material is present in the admixture from 5% to 60% based on the total weight of the admixture, and the surfactant is present in the admixture from 0.1% to 20% based on the total weight of the admixture. Preferably, the polymer is present in the admixture from 0.5% to 20% based on the total weight of the admixture, the hydrophobic material is present in the admixture from 20% to 50% based on the total weight of the admixture, and the surfactant is present in the admixture from about 3% to about 15% based on the total weight of the admixture.

Generally, when the admixture is added to a cementitious mixture, the admixture is added in an amount from 2 to 40 fluid ounces per hundred weight of cement (oz./cwt) (130.4-2607.9ml/100Kg). Preferably, the admixture is added in an amount from 4 to 20 oz./cwt (260.8-1303.9ml/100Kg).

If the polymer, surfactant, and hydrophobic material are each added separately to a cementitious mixture, the polymer is added in an amount from 0.00001Kg. to 0.01Kg. per Kg. of cement, the surfactant is added in an amount from 0.000001Kg. to 0.0001Kg. per pound of cement, and the hydrophobic material is added in an amount from 0.01Kg. to 0.4Kg. per pound of cement.

The cement in the cementitious composition can be any known cement. Suitable types of cement include, but are not limited to, calcium aluminate cement, hydratable alumina, hydratable aluminum oxide, colloidal silica, silicon oxide, portland cement, magnesia, pozzolan containing cements, and mixtures thereof. Preferably, the cement is Type I portland cement.

The cementitious composition can also contain any other known additive for cement that does not affect the desired properties of the present invention. Types of additives include, but are not limited to, set accelerators, set retarders, air-entraining agents, air-detraining agents, foaming agents, defoaming agents, corrosion inhibitors, shrinkage-reducing agents, pozzolans, dispersing agents, pigments, coarse aggregate, and fine aggregate. Other additives that can be used in cementitious compositions can be found in United States Patent No. 5,728,209 to Bury et al., which is incorporated herein by reference. Fine aggregates are materials that pass through a Number 4 sieve (ASTM C125 and ASTM C33), such as silica sand. Coarse aggregates are materials that are retained on a Number 4 sieve (ASTM C125 and ASTM C33), such as silica, quartz, crushed round marble, glass spheres, granite, limestone, calcite, feldspar, alluvial sands, or any other durable aggregate, and mixtures thereof.

The admixture of the present invention imparts water repellant properties and prevents water permeation in poured concrete and in articles formed from cementitious compositions. These articles can include wet cast concrete, dry cast concrete, and manufactured concrete products. Without being limited to theory, it is theorized that the hydrophobic material provides the water repellent properties. By being mixed into the cementitious mixture, the hydrophobic material is substantially evenly distributed in the cementitious matrix, as well as on the surface, where it prevents the wetting of the cementitious article, and also reduces the efflorescence. This prevents water from entering or releasing from the cementitious structure, which can be porous. This is particularly the case for manufactured concrete products, such as blocks, pavers, and retaining wall units.

The polymeric material provides further resistance to prevent water permeation, particularly when the water is being driven against the surface of the cementitious article, such as during a rain storm. The polymeric material closes the inter-connected porosity inside the cementitious article to prevent water from penetrating through the cementitious article. Preferably, the particle size of the polymer is from 0.3 to 10μM to allow blocking of the pores in the cementitious article.

The admixture can also function as a lubricant and plasticizer. In a molding operation, this can reduce the friction between the cementitious matrix and can increase the efficiency of a remolding process. Also, the admixture can increase the workability of concrete.

Cementitious articles containing the admixture of the present invention can also pass a vacuum test (ASTM C1244). One side of a cementitious article is subjected to a sustained pressure of 381mm Hg for three minutes. The cementitious article is able to maintain the pressure with no more than a 12.7mm loss of vacuum.

Cementitious articles formulated with the admixture of the present invention are also able to pass the freeze-thaw test of ASTM C1262 with a weight loss of less than 1% after 200 cycles of freezing and thawing. The cementitious articles can also meet the requirements of ASTM C1372 for segmental retaining wall units.

Also, these cementitious articles have an increased compressive strength (as measured by ASTM C90 or ASTM C140), because of the retention of more water in the system, which is used for more hydration. The increase has been measured as being up to 30% or more. Also, in the manufacture of cast articles, the production cycle time can be reduced up to 10% or more.

Advantages of the present invention include low permeability, low shrinkage for better bonding and less cracking, and better environmental impact.

The above described invention can be demonstrated by, but is not limited to, the following examples.

Example 1

Samples were prepared as 8"x8"x16" (20.32x20.32x40.64cm), 2-core medium weight blocks. The blocks were made from a typical mixture containing cement, aggregate, an admixture, and a sufficient amount of water for casting a block. The admixture for each set of testing that was added to the block mixture is indicated below. The amount of admixture added was based on adding the admixture at ml/100Kg. The blocks were tested according to ASTM C140 for compressive strength, the results for each test are indicated in the tables below, and according to ASTM C90 for compressive strength for loadbearing concrete masonry units. Set A was a mixture that contained a competitive water repellant admixture, 100S, from Sika, Zürich, Switzerland. Sets B-D contained an admixture that contained 40% butyl stearate, 3% carboxylated styrene butadiene latex, 8% ethoxylated nonylphenol, and 49% water by weight.

SET A

Admixture - Reference Mix (100s @ 130.4ml/100Kg (2 oz/cwt))

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (Mpa)		Received Weight (Kg.)
			Gross Area	Net Area	
A-1	0.077	54441	6.963	13.583	15.60
A-2	0.077	49614	6.343	12.342	15.45
A-3	0.077	51021	6.550	12.686	15.36

These blocks failed the compressive strength requirements of ASTM C90.

SET B

Admixture @ 130.4ml/100Kg (2 oz/cwt)

Test	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
B-1	0.077	55035	7.040	13.927	15.57
B-2	0.077	55112	7.040	13.996	15.62
B-3	0.077	58814	7.515	14.893	15.83

These blocks passed the compressive strength requirements of ASTM C90.

SET C

Admixture @ 391.2ml/100Kg (6 oz/cwt)

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
C-1	0.077	49134	6.274	12.480	15.59
C-2	0.077	53761	6.895	13.652	15.64
C-3	0.077	47183	5.998	11.928	15.56

These blocks failed the compressive strength requirements of ASTM C90.

SET D

Admixture @ 1629.9ml/100Kg (25 oz/cwt)

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
D-1	0.077	60175	7.653	14.962	16.23
D-2	0.077	61635	7.860	15.375	16.47
D-3	0.077	65191	8.343	16.272	16.47

These blocks passed the compressive strength requirements of ASTM C90.

The mixtures from Sets A-D were repeated and formed as blocks as above. The compressive strength and absorption were tested according to ASTM C140. The results are listed below.

SET A

Admixture - Reference Mix (100s @ 10.4ml/100Kg (2 oz/cwt))

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
A-4	0.077	64338	8.205	15.720	15.69
A-5	0.077	66451	8.481	16.823	15.62
A-6	0.077	64256	8.205	16.203	15.71

Unit	Dimensions (cm.)			Face Shell Thickness (cm.)		
	Length	Width	Height	Minimum Side	Opposite Side	Average
A-4	39.65	19.35	19.43	3.2	3.2	3.2
A-5	39.65	19.38	19.38	3.2	3.22	3.22
A-6	39.65	19.38	19.43	3.2	3.2	3.2

Unit	Web Thickness (cm.)			Min. End Flange Thickness (cm..)	Equivalent Web Thickness (cm..)
	W-1	W-2	W-3		
A-4	2.61	2.64	2.54	5.08	6.02
A-5	2.57	2.67	2.64	5.05	6.04
A-6	2.57	2.64	2.61	5.05	5.99

Unit	Absorption Kg/M^3	Density Kg/M^3	Moisture as Received		% Total Absorbed
			as % total absorbed	as % dry weight	
A-4	192.22	1954.25	39	4	10
A-5	208.24	1970.27	39	4	11
A-6	208.24	1986.29	46	5	10

Unit	Net Volume (M^3x10^{-3})	Gross Volume (M^3x10^{-3})	Net Area % Solid	Net Area (cm^2)	Received Weight (Kg)
A-4	7.787	14.895	52.3	1019.27	15.74
A-5	7.504	14.866	50.5	983.22	15.40
A-6	7.561	14.923	50.7	989.78	15.76

Equivalent Thickness=9.9cm

Fire Rating (BOCA National Building Code/Tab;e 4.7,1, 1994)=1.9 hours

These blocks pass the requirements of ASTM C90 for Type 2 units.

SET B

Admixture @ 10.4ml/100Kg (2 oz/cwt)

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
A-4	0.077	72404	9.239	18.202	15.49
A-5	0.077	75642	9.653	19.857	15.84
A-6	0.077	74753	9.515	18.823	15.82

Unit	Dimensions (cm.)			Face Shell Thickness (cm.)		
	Length	Width	Height	Minimum Side	Opposite Side	Average
A-4	39.67	19.41	19.33	3.20	3.20	3.20
A-5	39.65	19.35	19.38	3.18	3.25	3.20
A-6	39.65	19.35	19.43	3.20	3.25	3.23

Unit	Web Thickness (cm.)			Min. End Flange Thickness (cm.)	Equivalent Web Thickness (cm.)
	W-1	W-2	W-3		
A-4	2.61	2.64	2.54	5.08	5.99
A-5	2.59	2.61	2.54	5.08	5.97
A-6	2.59	2.61	2.61	5.08	6.02

Unit	Absorption Kg/M^3	Density Kg/M^3	Moisture as Received		% Total Absorbed
			as % total absorbed	as % dry weight	
A-4	208.24	1970.27	45	5	11
A-5	224.26	2050.36	45	5	11
A-6	176.20	2018.33	43	4	9

Unit	Net Volume (M^3x10^{-3})	Gross Volume (M^3x10^{-3})	Net Area % Solid	Net Area (cm^2)	Received Weight (Kg)
A-4	7.532	14.866	50.7	989.78	15.61
A-5	7.249	14.866	48.8	950.45	15.62
A-6	7.561	14.923	50.7	988.14	15.88

Equivalent Thickness= 9.65cm.

Fire Rating (BOCA National Building Code/Tab;e 4.7,1, 1994)=1.9 hours

These blocks pass the requirements of ASTM C90 for Type 2 units.

SET C

Admixture @ 391.2ml/100Kg (6 oz/cwt)

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
A-4	0.077	68221	8.687	17.306	15.79
A-5	0.077	63858	8.136	16.134	15.49
A-6	0.077	66271	8.481	16.823	15.82

Unit	Dimensions (cm.)			Face Shell Thickness (cm.)		
	Length	Width	Height	Minimum Side	Opposite Side	Average
A-4	39.65	19.35	19.46	3.15	3.28	3.20
A-5	39.62	19.35	19.46	3.20	3.25	3.23
A-6	39.62	19.38	19.41	3.18	3.23	3.20

Unit	Web Thickness (cm)			Min. End Flange Thickness (cm.)	Equivalent Web Thickness (cm.)
	W-1	W-2	W-3		
A-4	2.51	2.64	2.64	5.05	6.02
A-5	2.61	2.64	2.57	5.08	6.02
A-6	2.64	2.67	2.57	5.08	6.05

Unit	Absorption Kg/M^3	Density Kg/M^3	Moisture as Received		% Total Absorbed
			as % total absorbed	as % dry weight	
A-4	224.26	1970.27	42	5	11
A-5	208.24	2002.31	48	5	10
A-6	208.24	1986.29	43	4	11

Unit	Net Volume (M^{3}x10^{-3})	Gross Volume (M^{3}x10^{-3})	Net Area % Solid	Net Area (cm^2)	Received Weight (Kg)
A-4	7.532	14.923	50.5	983.22	15.54
A-5	7.561	14.923	50.7	986.50	15.88
A-6	7.504	14.895	50.4	981.59	15.61

Equivalent Thickness=9.65 cm.

Fire Rating (BOCA National Building Code/Tab;e 4.7,1, 1994)=1.9 hours

These blocks pass the requirements of ASTM C90 for Type 2 units.

SET D

Admixture @ 1629.9ml/100Kg (25 oz/cwt)

Unit	Gross Area M^2	Total Load Kg.	Compressive Strength (MPa)		Received Weight (Kg.)
			Gross Area	Net Area	
A-4	0.077	86647	11.101	21.650	16.25
A-5	0.077	86012	10.963	21.512	16.45
A-6	0.077	81104	10.342	20.271	16.43

Unit	Dimensions (cm.)			Face Shell Thickness (cm.)		
	Length	Width	Height	Minimum Side	Opposite Side	Average
A-4	39.67	19.41	19.43	3.20	3.20	3.20
A-5	39.67	19.41	19.46	3.20	3.23	3.20
A-6	39.73	19.46	19.41	3.20	3.20	3.20

Unit	Web Thickness (cm.)			Min. End Flange Thickness (cm.)	Equivalent Web Thickness (cm.)
	W-1	W-2	W-3		
A-4	2.61	2.64	2.57	5.08	5.99
A-5	2.64	2.64	2.54	5.08	6.02
A-6	2.641	2.64	2.57	5.08	5.99

Unit	Absorption Kg/M^3	Density Kg/M^3	Moisture as Received		% Total Absorbed
			as % total absorbed	as % dry weight	
A-4	176.20	2050.36	58	5	8
A-5	176.20	2050.36	57	5	9
A-6	176.20	2050.36	51	4	8

Unit	Net Volume (M^3x10^{-3})	Gross Volume (M^3x10^{-3})	Net Area % Solid	Net Area (cm^2)	Received Weight (Kg)
A-4	7.617	14.951	50.9	60.8	16.42
A-5	7.617	14.951	50.9	60.7	16.37
A-6	7.617	14.951	50.9	60.8	16.29

Equivalent Thickness= 9.65 cm.

Fire Rating (BOCA National Building Code/Tab;e 4.7,1, 1994)=1.9 hours

These blocks pass the requirements of ASTM C90 for Type 2 units.

<u>Experiment 2</u>

Several comparative mixtures were prepared and cast into blocks at different block manufacturing facilities. The compositions and the test run for each mix are detailed below in Tables 2-1 and 2-2. The admixture contained 40% butyl stearate, 3% carboxylated styrene butadiene latex, 8% ethoxylated nonylphenol, and 49% water by weight. Also, sufficient amount of water was added in order to provide a castable mixture.

TABLE 2-1

Material	Unit	1 (Control)	2	3	4
Cement, Type 1	Kg	204.1	204.1	204.1	195
Slag Cement	Kg	22.7	22.7	22.7	20.4
Cement Reduction	%	--	0%	0%	5%
Slag Cement %	%	0%	10%	10%	9%
Sand	Kg	526.2	526.2	526.2	526.2
Pea Rock	Kg	471.7	471.7	471.7	471.7
#10 Screenings	Kg	816.5	816.5	816.5	816.5
water repellant admixture sold under the name RHEOMIX® 235 from Master Builders, Inc., Cleveland, Ohio	ml	1035.10	0	0	0
Plasticizer sold under the name RHEOMIX® 630S from Master Builders, Inc., Cleveland, Ohio	ml	59.15	0	0	0
Non-chloride accelerator sold under the name POZZOLITH® NC 534, from Master Builders, Inc., Cleveland, Ohio.	Ml	2070.15	2070.15	2070.15	2070.15
Admixture	Ml	0	59.15	118.30	118.30
Test Results					
Plastic Appearance		good	good	good	Good
Swipe		light	trace	lt.-mod.	lt.-mod.
1 day gross strength	Mpa	8.136	8.639	7.729	7.191
% of Control	%	--	106.2%	95.0%	88.4%
7 day gross strength	Mpa	10.452	9.715	9.370	10.604
% of Control	%	--	92.9%	89.6%	101.5%
Production Increase					
Feed time	Sec	1.70	1.50	1.50	1.30
Cycle time	Sec	7.60	7.20	7.40	7.30
Cycles/Min	#	7.89	8.33	8.11	8.22
Est. cycle time	Sec	7.60	7.20	7.40	7.30
Cycle Time Reduction	Sec	--	0.40	0.20	0.30
Cycle Time Reduction	%	--	5.3%	2.6%	3.9%
Production Increase	%	0	5.3	2.6	3.9
Strength Increase					
1 day	%	--	6.2%	-5.0%	-11.6%
7 day	%	--	-7.1%	-10.4%	1.5%

The results in Table 2-1 show that the inventive admixture increased the compressive strength and reduced the cycle time to manufacture cast blocks.

TABLE 2-2

Material	Unit	1 (Control)	2	3	4	5
Cement, Type 1	Kg	403.7	403.7	403.7	362.9	362.9
Fly ash	Kg	0	0	0	0	0
Cement Reduction	%	--	0%	0%	10%	10%
Fly ash %	%	0%	0%	0%	0%	0%
Sand	Kg	1831.6	1831.6	1831.6	1831.6	1831.6
Pea Rock	Kg	148.8	148.8	148.8	148.8	148.8
#10 Screenings	Kg	1224.7	1224.7	1224.7	1224.7	1224.7
MAXIPLAST plasticizer from W.R. Grace, Cambridge, MA	ml	118.3	0	0	0	0
Polymeric carboxylate backbone with polyether group side chains dispersant, sold as RHEOMIX® 730FC-S from Master Builders, Inc., Cleveland, Ohio	ml	0	798.50	1330.80	1182.95	0
DARACCEL calcium chloride based accelerator from W.R. Grace, Cambridge, MA	ml	2661.60	2661.60	2661.60	2661.60	2661.60
Admixture	ml	0	0	0	0	473.20
Test Results						
Plastic Appearance		good	v. tight	v. tight	good	best
Swipe		trace	none	none	trace	light
14 day net strength	MPa	11.307	10.963	11.376	10.411	9.515
% of Control	%	--	97.0%	100.6%	92.1%	84.1%
Production Increase						
Feed time	Sec	1.70	1.50	1.50	1.30	1.30
Cycle time	Sec	7.55	7.13	7.32	7.14	6.80
Cycles/Min	#	7.95	8.42	8.20	8.40	8.82
Est. cycle time	Sec	7.55	7.13	7.32	7.14	6.80
Cycle Time Reduction	Sec	--	0.42	0.23	0.41	0.75
Cycle Time Reduction	%	--	5.6%	3.0%	5.4%	9.9%
Production Increase	%	0.0%	5.6%	3.0%	5.4%	9.9%
Strength Increase						
28 day	%	--	-3.0%	0.6%	-7.9%	-15.9%

The results in Table 2-2 show that the inventive admixture provided the best plastic appearance of cast blocks, and it decreased the manufacturing cycle time to cast blocks.

Example 3

Samples were prepared and tested according to ASTM C140, ASTM1262, and ASTM 1372. The samples were prepared from a mixture containing 200 kg of Type 10 cement, 1290 kg of concrete sand, 860 kg of birds-eye stone, 0.4 liters of a polymeric carboxylate backbone with polyether group side chains dispersant, sold as RHEOMIX®

730FC-S from Master Builders, Inc., Cleveland, Ohio, 0.6 liters of an admixture containing 40% butyl stearate, 3% carboxylated styrene butadiene latex, 8% ethoxylated nonylphenol, and 49% water by weight, and a sufficient amount of water to provide a castable mixture. The mixture was cast into full size units with the measurements described below in Table 3-1. From each unit, a 2"x4"x8" (5.08cmx10.16cmx20.32cm) coupon was cut from the unit for compression testing, the results of which are detailed in Table 3-2. Also, an additional sample was taken from the unit for absorption testing in accordance with ASTM C140, the results of which are detailed in Table 3-3.

Table 3-1

Unit	Estimated Width* (in.)	Average Height (cm.)	Average Length (cm.)	Received Weight (Kg)
1	29.79	19.61	44.83	35.90
2	29.57	19.66	44.73	35.44
3	29.69	19.61	44.73	35.07
4	29.57	19.66	44.83	35.76
5	29.59	19.63	44.73	35.61
Average	29.64	19.63	44.873	35.52

* The width dimension of this unit included a split surface. Therefore, this dimension was an estimated average rather than an average calculated from measured dimensions. Variations from the specified dimensions do no include the width dimension.

Maximum Variation from Specified Dimensions = 0.050 cm.

Maximum Permitted Variation from Specified = 0.318 cm.

Variation Between Heights of Measured Specimens = 0.025 cm.

Table 3-2

Unit	Avg. Width (cm.)	Avg. Height (cm.)	Avg. Length (cm.)	Coupon Weight (Kg.)	Max. Comp. Load (Kg.)	Tested Comp. Strength (MPa)	h/t	h/t correct. factor	Correct. Comp. Strength (MPa)
1	4.95	10.16	20.47	2.26	28876	27.924	2.05	1.01	28.069
2	4.88	10.21	20.42	2.18	27170	26.752	2.09	1.01	27.007
3	4.90	10.13	20.40	2.20	29302	28.737	2.07	1.01	28.930
4	4.88	10.19	20.42	2.24	29302	28.855	2.08	1.01	29.110
5	4.88	10.13	20.47	2.18	26209	25.745	2.08	1.01	25.945
Avg.	4.90	10.16	20.45	2.20	28172	27.579			27.786

"h/t" is the ratio of the average height of the block to the average width.

Table 3-3

Unit	Received Weight (Kg.)	Immersed Weight (Kg.)	Saturated Surface - Dry Weight (Kg.)	Oven-Dry Weight (Kg.)	Absorption		Kg/M^3
					Kg/M^3	%	
1	2.04	1.19	2.09	1.99	112.13	5.0	2228.17
2	2.03	1.18	2.07	1.97	115.33	5.2	2210.55
3	2.00	1.17	2.05	1.95	118.54	5.4	2208.95
4	2.00	1.17	2.05	1.95	112.13	5.0	2223.36
5	1.97	1.15	2.02	1.92	116.93	5.3	2197.73
Average	2.01	1.17	2.06	1.96	115.33	5.2	2213.75

The results in Tables 3-2 and 3-3 show that cementitious articles formulated using the admixture of the present invention exceed the requirements for ASTM C1372. ASTM C1372 requires a minimum net compressive strength of 3000 psi (20.684 Mpa) and an absorption of no more than 13 lb/ft^3 (208.24Kg/M^3).

For freeze-thaw testing according to ASTM 1262, five samples were prepared as above. Samples from the full size unit were cut to 1.25"x4"x8" (3.175cmx10.16cmx20.32cm). The weight of each sample is listed below in Table 3-4, the accumulative residue weight is listed below in Table 3-5, and the specimen weight loss percentage is listed below in table 3-6. The samples went through 200 freeze thaw cycles in water.

Table 3-4

Unit	Received Weight (Kg.)	Calculated Oven-Dry Initial Weight (Kg.)
1	1.4370	1.4209
2	1.4174	1.3955
3	1.4281	1.4045
4	1.3663	1.3240
5	1.4141	1.3961

Table 3-5

Unit	Accumulative Residue Weight ($Kg.x10^{-4}$)				
	0 cycles	50 cycles	100 cycles	150 cycles	200 cycles
1	0	10.43	15.88	20.41	27.22
2	0	9.98	20.87	27.22	45.81
3	0	10.43	31.30	42.64	52.16
4	0	10.88	23.59	37.46	68.04
5	0	10.43	20.87	34.48	56.70

Table 3-6

Unit	Specimen Weight loss (%)				
	0 cycles	50 cycles	100 cycles	150 cycles	200 cycles
1	0	0.1	0.1	0.1	0.2
2	0	0.1	0.1	0.2	0.3
3	0	0.1	0.2	0.3	0.4
4	0	0.1	0.2	0.3	0.5
5	0	0.1	0.1	0.2	0.4

The results in Tables 3-5 and 3-6 show that cementitious articles formed using the admixture of the present invention surpass the requirements for ASTM C1262.

Additionally, samples were prepared and tested as above for testing according to ASTM C1262, except that salt water was used in place of water for the freeze thaw testing. This testing does not conform to any standardized testing requirement, but was run for informational purposes only. Because of the salt water, the samples were only tested through 15 cycles. The weight of each sample is listed below in Table 3-7, the accumulative residue weight is listed below in Table 3-8, and the specimen weight loss percentage is listed below in table 3-9.

Table 3-7

Unit	Received Weight (Kg.)	Calculated Initial Weight (Kg.)
1	1.4309	1.4146
2	1.4220	1.4017
3	1.4275	1.3952
4	1.4378	1.4177
5	1.4364	1.4211

Table 3-8

Unit	Accumulative Residue Weight (Kg.)	
	0 cycles	15 cycles
1	0	0.2329
2	0	1.4017
3	0	0.6731
4	0	0.1140
5	0	0.0124

Table 3-9

Unit	Specimen Weight Loss (%)	
	0 cycles	15 cycles
1	0	16.5
2	0	100.0
3	0	48.2
4	0	8.0
5	0	0.9

Although the invention has been described in detail through the above detailed description and the preceding examples, these examples are for the purpose of illustration only and it is understood that variations and modifications can be made by one skilled in the art without departing from the spirit and the scope of the invention.

CLAIMS

What is claimed is:

1. An admixture for cementitious compositions comprising a polymer, a surfactant, and a hydrophobic material that is an organic ester of an aliphatic carboxylic acid.

2. The admixture of claim 1, wherein the organic ester of an aliphatic carboxylic acid is represented by the general formula R_1-R_2, wherein R_1 is C_{12}-C_{18} aliphatic carboxylic acid ester, and R_2 is a linear or branched C_1 to C_{10} alkyl.

3. The admixture of claim 1, wherein the hydrophobic material is selected from the group consisting of butyl stearate, butyl oleate, and mixtures thereof.

4. The admixture of claim 1, wherein the polymer is selected from the group consisting of styrene butadiene copolymers, polyacrylate latex, polymethacrylate latex, carboxylated styrene latex, isoprene-styrene copolymer, and mixtures thereof.

5. The admixture of claim 1, wherein the polymer has a number average molecular weight from 500 to 50,000.

6. The admixture of claim 1, wherein the polymer is present in the admixture from 0.5% to 20% based on the total weight of the admixture, the hydrophobic material is present in the admixture from 5% to 60% based on the total weight of the admixture, and the surfactant is present in the admixture from 0.1% to 20% based on the total weight of the admixture.

7. A cementitious composition comprising cement, a polymer, a surfactant, and a hydrophobic material that is an organic ester of an aliphatic carboxylic acid.

8. The cementitious composition of claim 7, wherein the polymer, the surfactant, and the hydrophobic material are added to the cement as an admixture.

9. The cementitious composition of claim 8, wherein the polymer is present in the admixture from 0.5% to 20% based on the total weight of the admixture, the hydrophobic material is present in the admixture from 5% to 60% based on the total

weight of the admixture, and the surfactant is present in the admixture from 0.1% to 20% based on the total weight of the admixture.

10. A method of forming a cementitious composition comprising mixing the cement, the polymer, the hydrophobic material, the surfactant, from any of claim 8-9 with water.