HIGH PERFORMANCE CHEMICAL ADMIXTURES FOR DURABLE CONCRETE

batimix®

Edition 1.0

Company overview

Holderchem Building Chemicals S.A.L. was founded in 1994 as a joint venture with Holcim, the world's leading Portland cement producer. It has since developed by virtue of technically innovative ideas, dedicated customer services, and highly skilled staff to become a main independent supplier to the cement and building industries in Lebanon as well as Middle East and Gulf countries.

A wide and full range of products are available at Holderchem Building Chemicals S.A.L. meeting the most challenging requirements of modern construction. These include concrete admixtures, ready-to-use masonry mortars, tile adhesives, curing and sealing compounds, epoxy adhesives, injection grouts, concrete repair and waterproofing products, protective coatings, pavement sealers, and miscellaneous other specialty building materials. The products are specifically designed and tested in laboratory according to relevant international standards including ISO, EN, and ASTM. The R & D is carried out by a qualified team of professionals in close coordination with Clients on a project-by-project basis to meet various construction requirements and site-conditions. Holderchem Building Chemicals S.A.L. provides complete laboratory support and specification assistance as well as on-site service to ensure proper usage and application of all supplied products.

Introduction

Admixtures of various chemical classes and functions are essential components for the design of durable and cost-effective concrete structures. Different physical and chemical features can result from the interaction of such materials with the cement particles. For example, plasticizers are powerful polymeric dispersants which physically break-up cement agglomerates and liberate the trapped mixing water. On the other hand, the kinetics of cement hydration can be altered by the use of set-modifiers which chemically block or promote the hydration of cement compounds.

The consequences of such physico-chemical features lead to important benefits in the fresh and hardened concrete properties. For example, plasticizers improve workability while allowing a reduction in mixing water which would lead to lower amount in capillary porosity of the hardened concrete. Set-accelerators are added to shorten setting time of concrete which is important to accelerate finishing operations and removal of formwork. Under hot weather conditions, set-retarders are used to prevent the rapid loss of workability and formation of cold joints in large pours.

Products range

Holderchem Building Chemicals S.A.L. offers a complete line of high performance chemical admixtures for the concrete industry. The products, supplied under the **batimix.** name, drastically improve the fresh and hardened properties paving the way for major new developments in concrete technology and practices. All types of concrete including specialty mixtures such as self-consolidating, architectural, shotcrete, lightweight, and underwater may thus be formulated.

The **batimix.** admixtures are engineered to meet all EN and ASTM standards for Admixtures for Concrete. The products are field-proven with value-added resources to engineers and contractors. These include:

- Water reducers to improve concrete workability and/or allow reduction in mixing water. Such admixtures are designed to effectively perform under moderate, cold, and hot weather conditions
- Air entrainers to improve resistance against freeze/thaw cycles and set-modifiers to modify hydration of cement
- Specialty admixtures to enhance specific properties such as water impermeability and overall durability.

Experimental program

One concrete mix design was used throughout the development of this brochure (TABLE 1). Portland cement conforming to ASTM C 150 Type I was used at a fixed dosage of 350 kg/m^3. It had C_3S, C_3A, and NaO_{eq}. characteristics of 60%, 6.4%, and 0.74%, respectively, with a Blaine specific surface of 325 m^2/kg.

The water content, however, was variable depending on the desired strength and type of water reducer used. Crushed limestone aggregates and well-graded siliceous sand conforming to ASTM C 33 were employed. The specific gravities of the sand, crushed sand, medium and coarse aggregates were 2.62, 2.55, 2.65, and 2.74, respectively.

TABLE 1 **Concrete mix design**

Portland cement	350 kg/m^3
Water	Various
Total aggregate	1850±100 kg/m^3
Fine aggregate (0-7 mm)	42 %
Coarse aggregate (7-20 mm)	58 %
Ratio of coarse to fine	1.38

batimix® water reducing admixtures

Three different grades of soluble polymeric water reducers are available at Holderchem Building Chemicals S.A.L., as summarized in TABLE 2. They are specifically used to improve dispersion of cement particles in concrete mixtures.

batimix® WR series are composed of refined lignosulphonate raw materials free from all foreign particles that could excessively entrain air and severely retard setting. They are proportioned to allow up to 14% reduction in the free water content, thus leading to higher strength without any loss in workability. The dispersion mechanism is achieved by molecule adsorption onto the surface of the hydrating cement grains, conveying to these surfaces a negative electrical charge which minimizes cement particle agglomeration.

batimix® MWR series are mixtures composed of various combinations of refined lignosulphonate and high grade water soluble naphthalene-sulphonate molecules. Their key features are to significantly improve concrete workability and/or allow up to 30% reduction in free water content. Their surface potentials generate powerful electrostatic repulsion between neighbouring cement particles, thus promoting deflocculation and dispersion of these particles.

batimix® HWR series are made from high concentrations of naphthalene-sulphonate or polycarboxylate acid polymers, allowing up to 40% reduction in free water. These highly effective dispersants are used to achieve and control high workability of fresh concrete, even at very low W/C, without adversely affecting other properties such as bleeding, setting time, and strength. The deflocculation effect is achieved by electrostatic repulsion and short-range particle repulsion due to steric hindrance.

TABLE 2 **batimix® water reducers for use in moderate weather conditions**

		ASTM compliance*	Specific gravity	Dosage rates, % c.w.	Water reduction$, %
Water reducers	WR 100	C 494 Type A	1.11	0.4 to 1.6	8
	WR 200		1.13	0.4 to 1.5	10
	WR 300		1.16	0.2 to 1.3	12
	WR 400		1.18	0.2 to 1.2	14
Mid-range water reducers	MWR 500	C 494 Type A and C 494 Type F	1.18	0.3 to 1.6	17
	MWR 600		1.19	0.3 to 1.6	20
	MWR 700		1.20	0.3 to 1.8	22
	MWR 800		1.18	0.4 to 2.2	24
	MWR 900		1.19	0.4 to 1.8	27
	MWR 1000		1.20	0.4 to 2.0	30
High-range water reducers	HWR 1100	C 494 Type F and C 1017 Type I	1.21	0.5 to 2.0	32
	HWR 1200		1.20	0.6 to 2.5	34
	HWR 1300		1.22	0.5 to 2.0	37
	HWR 1400		1.21	0.6 to 2.3	40
	HWR 1500**		1.11	0.2 to 1.5	40

* All products also conform to EN 934-2

** HWR 1500 is a polycarboxylate acid-based admixture

$ Percent of water reduction is determined at relatively moderate to high dosage rates

TESTING PROGRAM AND RESULTS

To demonstrate the impact of **batimix.** water reducers on concrete properties and their range of application, a comprehensive experimental program was undertaken with test results summarized in TABLE 3.

The W/C varied between 0.55 and 0.40 corresponding to ratios commonly used for designing ordinary and high performance concrete, respectively. On the other hand, targeted initial slump values ranged from 100 mm in lean mixtures with higher W/C to around 230 mm for lower W/C mixtures. This was done to demonstrate the effectiveness of water reducers and to cover a wider range of workability that could be encountered at the job-site.

The properties evaluated include the slump (ASTM C 143), compressive strength on 100 x 200 mm cylinders (ASTM C 39), and flexural strength on 100 x 100 x 400 mm prisms (ASTM C 78). Reference mixtures made without any water reducers and having initial slump values of 100, 150, and 200 mm were also tested.

TABLE 3 **Typical concrete properties made with various types and dosages of batimix. water reducers***

		W/C	Dosage, % of c.w.	Concrete properties determined at 20°C and 60% R.H.		
				Slump, mm (initial, after 30 and 60 min)	Compressive strength, MPa (after 24 h, 7 and 28 days)	Flexural strength, MPa (after 7 and 28 days)
Water reducers	Reference mix	0.60	N/A	100 – 40 – N/A	6.2 – 14.8 – 24.3	6.3 – 7.7
	WR 100	0.55	0.45	80 – 65 – 50	8.8 – 20 – 28.1	6.7 – 8.0
	WR 200	0.54	0.5	90 – 75 – 70	9.0 – 22.6 – 30.5	6.6 – 8.6
	WR 300	0.52	0.5	95 – 80 – 60	10.2 – 24.1 – 33.2	7.5 – 8.4
	WR 400	0.52	0.6	110 – 75 – 65	9.7 – 23.8 – 34.5	7.4 – 9.3
Mid-range water reducers	Reference mix	0.72	N/A	150 – 130 – 90	5.3 – 11.2 – 20	5.5 – 7.0
	MWR 500	0.51	0.9	110 – 75 – 70	11.4 – 21.6 – 34	8.5 – 9.6
	MWR 600	0.50	1.1	125 – 90 – 80	10.7 – 25.1 – 35.7	8.8 – 10.1
	MWR 700	0.48	1.4	150 – 100 – 95	12.2 – 23.4 – 38.7	9.3 – 11.0
	MWR 800	0.47	1.5	165 – 125 – 110	10.8 – 26.2 – 40	9.1 – 10.7
	MWR 900	0.46	1.6	170 – 135 – 100	9.8 – 28.8 – 39.2	10.0 – 11.5
	MWR 1000	0.46	1.7	180 – 130 – 95	11.2 – 30.6 – 41.4	9.7 – 11.3
High-range water reducers	Reference mix	0.80	N/A	200 – 150 – 105	2.6 – 6.7 – 16.3	3.8 – 6.4
	HWR 1100	0.44	1.85	190 – 140 – 105	11.3 – 32.5 – 43.5	10.6 – 12.5
	HWR 1200	0.42	2.1	195 – 125 – 90	12.6 – 29.6 – 44	11.2 – 13.0
	HWR 1300	0.42	1.9	200 – 155 – 110	9.1 – 30.9 – 42.6	10.8 – 12.3
	HWR 1400	0.40	2.05	220 – 215 – 160	14.1 – 35 – 45.8	12.2 – 14.8
	HWR 1500	0.40	1.0	225 – 210 – 170	14.5 – 32.4 – 44.6	12.0 – 13.7

* Values are given for indication purposes only, as they may significantly vary with the characteristics of raw materials and mixing conditions

GUIDE FOR SELECTION OF batimix® WATER REDUCERS

Strength and durability are largely function of the concrete porosity, which in turn is directly dependent on water content. Lower W/C leads to reduced amount of capillary porosity in the cement paste, and hence increased strength without increasing the cement content. This is illustrated in TABLE 3 as the incorporation of admixtures resulted in reduced water content and improved mechanical properties compared to reference mixtures.

Lignosulphonate-based products are particularly suitable for use in lean concrete mixtures with relatively higher W/C and cohesive workability levels. Secondary effects such as retardation of set and increased bleeding may arise if such products are used at higher dosages to produce flowing concrete. In such cases, products based on naphthalene-sulphonate polymers should be used to:

- increase concrete workability (slump) with no W/C alteration
- decrease W/C for high early and ultimate mechanical strengths
- decrease both water and cement, for a given workability and strength.

BLENDED batimix® WATER REDUCERS FOR USE IN EXTREME CONDITIONS

When cold or hot weather conditions prevail, fresh and hardened concrete properties may be adversely affected. For example, in cold temperatures, the rate of strength development may be seriously retarded, thus delaying the early stripping of formworks and finishing operations. On the other hand, a need to compensate rapid workability loss is essential when concreting is made in hot temperature.

Holderchem Building Chemical S.A.L. offers two blended sets of water reducers composed of similar types and combinations of water soluble polymers as those presented in TABLE 2; but, blended with carefully selected chloride-free set-modifiers. The products nomenclature, standard compliance, and dosage rates are summarized in TABLE 4, where:

- the "-S" letter designates "improved slump retention for use in hot weather concreting"
- the "-A" letter refers to "accelerated setting characteristics for use in cold weather concreting and/or when increased dosage rates are needed to produce flowing concrete without set-retardation."

TABLE 4 **Blended batimix® water reducers for use in extreme conditions**

Hot weather conditions where ambient temperatures are greater than 30°C			Cold weather conditions and/or when increased dosage rates are needed		
	ASTM compliance*	Dosages$		ASTM compliance*	Dosages$
WR 100-S	C 494 Type D	0.4 to 1.4	WR 100-A	C 494 Type E	0.4 to 1.8
WR 200-S		0.4 to 1.2	WR 200-A		0.4 to 1.6
WR 300-S		0.2 to 1.0	WR 300-A		0.2 to 1.4
WR 400-S		0.2 to 0.8	WR 400-A		0.2 to 1.3
MWR 500-S	C 494 Type D and C 494 Type G	0.3 to 1.2	MWR 500-A	Exceeds C 494 Type E in terms of water reduction and/or workability	0.3 to 1.8
MWR 600-S		0.3 to 1.2	MWR 600-A		0.3 to 1.8
MWR 700-S		0.3 to 1.4	MWR 700-A		0.3 to 2.0
MWR 800-S		0.4 to 1.8	MWR 800-A		0.4 to 2.6
MWR 900-S		0.4 to 1.4	MWR 900-A		0.4 to 2.2
MWR 1000-S		0.4 to 1.6	MWR 1000-A		0.4 to 2.4
HWR 1100-S	C 494 Type G and C 1017 Type II	0.5 to 1.5	HWR 1100-A	Exceeds C 494 Type E in terms of water reduction and/or workability	0.5 to 2.4
HWR 1200-S		0.6 to 1.8	HWR 1200-A		0.6 to 3.0
HWR 1300-S		0.5 to 1.5	HWR 1300-A		0.5 to 2.4
HWR 1400-S		0.6 to 1.8	HWR 1400-A		0.6 to 2.8
HWR 1500-S**		0.2 to 1.2	HWR 1500-A**		0.2 to 1.5

* All products also conform to EN 934-2
** HWR 1500-S and HWR 1500-A are polycarboxylate-acid based admixtures
$ Dosage rates are given in percent of cement weight

ADVANTAGES OF BLENDED batimix. WATER REDUCERS

Typical comparative results of three water reducers tested at similar W/C and dosage rates are summarized in TABLE 5.

Slump retention and early strength highly depend on the type of water reducer used. Mixtures made with products ending with the "-S" letter exhibit high slump retention over time without materially affecting strength development after 24 hours. This makes this type of water reducers suitable for hot weather concreting as they lengthen the working periods necessary for handling and finishing operations of the plastic concrete.

Mixtures made with products ending with the "-A" letter are shown to exhibit increased rates of strength development after 24 hours because of the set-accelerating chemicals blended in such water reducers. This is relevant in cold climates where retardation of early strength development, formwork stripping, and finishing operations may be detrimental for the construction.

TABLE 5 **Concrete properties made with blended batimix. water reducers**

	W/C	Dosage, % of c.w.	Concrete properties (20°C and 60% R.H.)	
			Slump, mm (initial, after 30 and 60 min)	Compressive strength, MPa (after 24 h and 28 days)
WR 200-S	0.52	0.8	120 – 110 – 100	7.5 – 32.9
WR 200-A	0.52	0.8	110 – 70 – 50	9.1 – 33.5
MWR 800-S	0.48	1.4	160 – 145 – 130	8.7 – 38.6
MWR 800-A	0.48	1.4	155 – 110 – 80	11.2 – 38.3
HWR 1400-S	0.44	1.5	200 – 190 – 175	8.1 – 45.3
HWR 1400-A	0.44	1.5	195 – 130 – 100	12.4 – 44.2

GENERAL GUIDELINES FOR USE OF batimix. WATER REDUCERS

I - Dosage rates

The optimum dosage of water reducers is best determined using actual concrete mix design with site materials under conditions that will be experienced in the field. TABLE 2 and TABLE 4 summarize the average dosage rates to be used.

II - Effect of overdosing

Exceeding the maximum water reducer dosage will increase concrete slump with noticeable signs of bleeding and segregation, particularly at W/C higher than 0.45. The effect of overdosing will generally lead to retardation in setting time and some increase in air content. If concrete is properly cured, the ultimate strength will not be impaired by such set-retardations.

III - Compatibility

The water reducers are compatible with all other Holderchem admixtures incorporated in the same concrete. The products are compatible with all types of Portland cement and replacement materials such as silica fume, fly ash, and furnace slag.

IV - Dispensing and mode of introduction

Accurate and reliable automatic dispensing systems should be used to introduce the correct quantity of water reducers in the concrete mixer. These products should not be directly added on the dry cementitious particles. They should be introduced towards the end of mixing, i.e. after incorporating the aggregate and cementitious phase with around 2/3 of the mixing water.

V - Packaging and storage

All of these products are delivered in bulk and in drums containing 4, 20, or 200 kg. They have a minimum shelf life of 12 months if kept unopened and stored at temperatures ranging from 0 to 50 °C.

VI - Health and safety

The water reducers are not hazardous products. However, they should not be swallowed or allowed to come into contact with skin and eyes. Suitable gloves and goggles should be worn. For additional information, kindly refer to the specific product's Material Safety Data Sheet.

batimix® air entrainers and set-modifiers

Holderchem Building Chemicals S.A.L. offers several grades of air entraining, set-retarding, and set-accelerating admixtures for use in concrete mixtures. The products nomenclature and description are summarized in TABLE 6. Properties and guidelines for use are given in TABLE 7.

I – AIR ENTRAINERS

Products from the batimix® AEA series are aqueous solutions of modified resins and naturally occurring surfactants. They act at the interference between mixing water and cement/aggregate particles to produce microscopic air bubbles dispersed evenly throughout the mass concrete. Features of such chemicals include:

- improved durability against freezing and thawing cycles
- reduced absorptivity of concrete, as air bubbles act as "air plugs"
- limitation of progressive cracks, as air bubbles dissipate energy at their tips
- enhanced workability, as air bubbles reduce internal friction and stickiness

TABLE 6 **Summary of batimix® air entrainers and set-modifiers**

		Standard compliance	Overall description
Air entrainers	AEA-110	EN 934-2 and ASTM C 260	General purpose air entrainer
	AEA-120		Concentrated air entrainer, less sensitive to concrete constituents and ambient temperature
Set-retarders	Retarder 210	EN 934-2 and ASTM C 494 Type B	General purpose set-retarder
	Retarder 220		Concentrated set-retarder with plasticizing effect
	Retarder 230		Set-retarder with plasticizing effect and improved slump retention properties
Set-accelerators	Accelerator 310	EN 934-2 and ASTM C 494 Type C	Calcium chloride-based set-accelerater
	Accelerator 320		Chloride-free, general purpose set-accelerater
	Accelerator 330		Chloride-free, set-accelerater with plasticizing effect for concrete
	Accelerator 340		Chloride-free, set-accelerater particularly suitable for shotcrete applications

II – SET-RETARDERS

Products from the batimix® Retarder series are synthetically produced liquid solutions based on modified gluconate organic polymers. They cover cement particles with a thin layer that neutralizes and temporarily blocks the hydration of C_3S and C_3A, thus delaying the precipitation of $Ca(OH)_2$. When the entire admixture has been combined, hydration reactions can then start normally leading to similar or greater 28-day strength. Features of such chemicals include:

- prolonged and controlled setting rates
- improved workability for similar W/C
- Enhanced slump retention over time
- reduced cold joints / discontinuities

III – SET-ACCELERATORS

Products from the batimix. Accelerator series are synthetically produced liquid solutions based on modified organic polymers. When introduced in cement pastes, they rapidly activate the hydration of cement compounds and result in faster setting and hardening.

Product # 310 is a chloride-based admixture for use in plain and non-reinforced concrete structures. Products # 320, 330, and 340 are chloride-free, making them suitable for structural, precast, or repair concrete applications. Features of such chemicals include:

- reduced initial and final setting times
- lower construction costs with no cold weather delays
- increased early strength for fast form stripping and finishing operations
- improved concrete cohesiveness with minimized bleeding and segregation

TABLE 7

Specific properties and guidelines for use of batimix air entrainers and set-modifiers for concrete

	Specific gravity	Dosages, % of c.w.	Introduction sequence	Effect of overdosing
AEA-110	1.01	0.05 to 0.5	Add after aggregate and 1/3 of water at the beginning of mixing	Overdosing results in a significant increase in air content, reducing strength to a level dependent on the particular mix. Increased air content improves workability of fresh concrete
AEA-120	1.02	0.05 to 0.4		
Retarder 210	1.12	0.2 to 1.0	Add after aggregate, cement, and 2/3 of water; but prior to introducing other chemicals such as water reducers	Overdosing results in excess set retardation, particularly in sulphate-resistant cement or in presence of replacement materials. This will prolong "greenness" with significantly slow development of intrinsic strength. If the concrete is properly cured, the ultimate strength will not be impaired by such retardation
Retarder 220	1.16	0.2 to 0.8		
Retarder 230	1.18	0.2 to 0.8		
Accelerator 310	1.25	0.8 to 4	Add after aggregates, cement, and 2/3 of water; but prior to introducing other chemicals such as water reducers	Overdosing results in an increased early stiffening (workability loss) together with an increased rate of strength development, especially after 24 hours. However, with the rapid initial acceleration of the cement hydration process, a slight loss in compressive strength may be noticed after 28 days
Accelerator 320	1.25	0.8 to 4		
Accelerator 330	1.31	0.8 to 3.5		
Accelerator 340	1.31	3 to 6		

Compatibility: These products are compatible with all types of Portland cement and other Holderchem Building Chemicals S.A.L. admixtures. They should not be pre-mixed with other chemical admixtures as this may alter their performances

Dispensing: Accurate automatic dispensing systems should be used to introduce the correct quantity in the concrete mixer to avoid variations in dosage

Packaging and health: These products are delivered in bulk and in drums containing 4, 20, or 200 kg. Their minimum shelf lives are 12 months if properly stored at temperatures ranging from 0 to 50 °C. Although they are not considered as hazardous products, they should not be swallowed or allowed to come into contact with skin and eyes. For additional information, kindly refer to the product's Material Safety Data Sheet

batimix® specialty concrete admixtures

Holderchem Building Chemicals S.A.L. offers a variety of chloride-free specialty admixtures to solve unique challenges in concrete construction by enhancing specific properties such as water impermeability, cohesiveness, and durability. Products description and dosage rates are summarized in TABLE 8.

I – INTEGRAL WATER-REPELLENTS

All cementitious-based systems are vulnerable to water penetration. This is due to the cement hydrating mechanism which, after setting, creates a porous material with an inter-connected system of gel and capillary pores. The use of integral admixtures is therefore of great importance to minimize the rate of moisture transmission through concrete.

The water insoluble stearates of the batimix® IWR 410 product react with the cement hydrating compounds to form a hydrophobic "water-repellent" coating in the concrete pores and voids, significantly reducing capillary suction and internal water movement. batimix® IWR 420-S is blended with plasticizer to improve workability.

TABLE 8 **Specialty batimix® products for specific uses**

	Dosages*	Overall description
IWR 410	0.2 to 1.0	Integral water-repellent for reduced water absorption in concrete
IWR 420-S	0.2 to 1.0	Integral water-repellent with plasticizing effect
VMA 510	0.2 to 0.8	Viscosity-modifier to control undesired bleeding and segregation
VMA 520-S	0.4 to 1.2	Viscosity-modifier / plasticizer for improved workability
VMA 530	0.2 to 0.8	Viscosity-modifier used as pumping aid admixture
AWA 540	0.5 to 1.4	Anti-washout admixture for underwater concreting works
Anti-Shrink 610	1 to 3	Reducer of shrinkage that occurs during the drying process
Anti-Corrosion 620	1 to 6	Corrosion-inhibitor for superior reinforcing steel protection
Anti-Frost 630	2 to 6	Setting accelerator to prevent frost attack in very cold climates
Cell 640	2 to 6	Oleate-based admixture to produce lightweight concrete
Alkali-Silica 650	0.8 to 2.5	Lithium-based agent to mitigate akali-silica reaction in concrete
Fiber 660	0.3 to 0.8	Secondary reinforcing fibers for increased resistance to cracking
Silica Fume 710	6 to 12	Powder additive to create denser, stronger, and durable concrete
Blend Cement 720	N/A	Ready-to-use binder composed by Type I cement and silica fume
Surface Retarder 730	3 to 8 m^2/ kg	Formwork coating for exposed coarse aggregate particles
Form Release 740	10 to 40 m^2/ kg	Mould release agent to reduce adhesion against concrete
Cure 750	2 to 5 m^2/ kg	Concrete surface curing admixture to reduce water evaporation

* Dosage rates are given in percent of cement weight, except for products # 730, 740, and 750.

batimix. IWR 410 or 420-S can be supplied in liquid or powder form. When used at normal dosages, the relative rate of water absorption is around 5 folds lower than reference mixtures. Applications using these products include all types of concrete structures where water-tightness is critical such as basement walls, foundations, tunnels, and silos. Primary features include:

- reduced water permeability, capillary suction, and moisture transfer
- no negative influence on drinking water in concrete storage tanks
- no detrimental effect on setting / strength
- reduced potential for efflorescence and rebar corrosion
- improved durability and protection against ingress of dampness, soluble salts, or other aggressive chemicals

It is important to mention that increased resistance against water penetration is highly dependent on good concrete practices including placing, vibrating, finishing, and curing.

II – VISCOSITY-MODIFIERS

Viscosity-modifiers are generally incorporated to enhance stability, i.e. bleeding and segregation of fresh concrete. They are characterized by their long-chains polymers that adhere to the periphery of mixing water in a cement paste. The chains intertwine and develop attractive forces through hydrogen bond and polymer entanglement, resulting in increased plastic viscosity and yield value even in high W/C mixtures.

batimix. VMA 510 is used to improve cohesion of flowable concrete (self-consolidating). It also acts as a sag-resistant material in shotcrete applications. The VMA 520-S is blended with dispersing polymers to enhance cement dispersion.

batimix. VMA 530 is recommended for pumped concrete. It offers good resistance to forced bleeding so that dewatering of concrete under the pressure of pumping is prevented.

batimix. AWA 540, called anti-washout admixture, is intended for underwater concreting to reduce the risk of water dilution and seperation of fine particles during casting.

Concrete modified with viscosity-modifiers exhibits increased degrees of thixotropy and stickiness, thus necessitating greater dosages of the superplasticizer to recover the desired workability without adding more water.

Typical mixture composition and properties for a self-consolidating concrete (SCC) is given in TABLE 9.

TABLE 9 **SCC mix design**

batimix. Blend Cement 720	420 kg/m³
Water (W/C = 0.45)	190 kg/m³
Natural sand (0 - 5 mm)	450 kg/m³
Crushed sand (2 - 7 mm)	410 kg/m³
Medium aggregate (5 - 10 mm)	790 kg/m³
batimix. VMA 510	1.25 kg/m³
batimix. HWR 1400-A	11.0 kg/m³
Initial slump flow	600 x 600 mm
Slump flow after 1 hour	470 x 460 mm
Setting time	13 to 16 hours
Compressive strength	
• at 24 hours	8 MPa
• at 7 days	35 MPa
• at 28 days	48 MPa

III – SPECIAL PURPOSE ADMIXTURES

batimix. Anti-Shrink 610 is used to reduce cracks on the concrete surface due to drying shrinkage. It does not contain expansive materials, but rather acts chemically to reduce the surface tension of water in the concrete capillary pores. When added at a dosage of 1.5% of cement weight, shrinkage reductions up to 30% are obtained as per ASTM C 157.

batimix. Anti-Corrosion 620 is a calcium nitrite-based admixture designed to inhibit corrosion of steel reinforcements. It prevents ferrous chloride complex formation by reacting with defective ferrous oxide ions prior to chloride attack and reforming the passive layer. This product is blended with set-retarding chemicals to offset any acceleration that may occur due to calcium nitrite.

batimix. Ant-Frost 630 is a chloride-free admixture, meeting ASTM C 494 Type C, which reduces frost attack during cold weather concreting by promoting cement hydration and increasing early strength development. It is to be noted that entraining air up to 8% is crucial to ensure long service life of concrete exposed to moisture and freezing temperatures.

batimix. Cell 640 is a fine oleate based admixture manufactured to meet ASTM C 869 requirements. It is used to produce foam when making cellular concrete for enhanced thermal and insulating properties. Used with lightweight aggregates, concrete with density as low as 650 kg/m^3 can be achieved.

batimix. Alkali-Silica 650 is a lithium based admixture used to significantly reduce expansion due to alkali-silica reaction which causes deterioration of concrete. The use of lithium compounds reduces silica dissolution and repolymerization of silica/silicates, thus decreasing repulsive forces between colloidal gel particles and resulting in a less expansive product.

batimix. Fiber 660 is a fiber monofilament additive available under different grades to meet the various requirements of ASTM C 1116. Such poducts are compatible with the normally alkaline environment within the cement paste, and highly resistant to moisture and service conditions. They totally disperse into the concrete mix to provide optimum strength, reduced cracking, and long-term durability.

IV – CONCRETE ADDITIVES

batimix. Silica Fume 710 is a powder microsilica raw material conforming to ASTM C 1240. When added in a concrete mix, it reacts chemically with the calcium hydroxide of the cement paste and leads to the formation of greater amount and stronger C-S-H gel. This product generates significant increases in strength and durability, together with improved particle packing and resistance against water permeability and chemical attack.

Compared to Portland cement, microsilicia is around 100 times finer and twice lighter, which makes its stockage and handling difficult at the job-site. Furthermore, modified concrete with such raw material should be mixed for longer elapsed times in order to achieve high degree of homogenization with the cement. In this context, **batimix.** Blend Cement 720 is offered to considerably facilitate the usage of microsilica at the job-site. It is made of Portland cement conforming to ASTM C 150 Type I blended with microsilica to enhance concrete properties. Typical compressive strength comparison is shown in TABLE 10.

TABLE 10 **Silica fume effect on compressive strength, MPa**

Ordinary cement	• at 24 hours	9.6
	• at 7 days	27.2
	• at 28 days	35.4
batimix Blend Cement 720	95% cement + 5% silica fume	
	• at 24 hours	11.2
	• at 7 days	29.5
	• at 28 days	38.1
	90% cement + 10% silica fume	
	• at 24 hours	12.7
	• at 7 days	31.6
	• at 28 days	42.5

batimix. Surface Retarder 730 is used to retard setting of the top cement paste layer. It is applied on the inner face of the formwork so that, after demoulding, concrete surface can be easily worked to expose agregates. It may also be used to produce mechanical keys for bonding subsequent applications.

batimix. Form Release 740 is a soluble non-staining oil used to reduce bonding and adhesion of concrete onto formworks. It promotes quick and easy stripping/cleaning of forms to provide maximum performance to precast concrete and other forming processes. This product also minimizes encapsulation of air in poured vertical sidewalls, allowing free air to rise more easily to the surface.

batimix. Cure 750 is a paraffin wax-based emulsion curing agent. It can be supplied under different characteristics to meet the various requirements of ASTM C 309. When sprayed onto the fresh concrete surface, these products form an impermeable protective film that stops the undesirable effects associated with too rapid evaporation of moisture. The resulting film will gradually disintigrate leaving a stain-free surface.

Important notes

Referenced EN & ASTM standards

EN 934-2 Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labeling
ASTM C 260 Standard specification for air entraining admixtures for concrete
ASTM C 309 Standard specification for liquid membrane-forming compounds for curing concrete
ASTM C 494 Standard specification for chemical admixtures for concrete
ASTM C 869 Standard specification for foaming agents used in making performed foam for cellular concrete
ASTM C 1116 Standard specification for fiber-reinforced concrete and shotcrete
ASTM C 1017 Standard specification for chemical admixtures for use in producing flowing concrete
ASTM C 1240 Standard specification for use of silica fume as a mineral admixture in hydraulic-cement concrete, mortar, and grout

Important notes

- For proper use of any specific product, users may consult the corresponding "Technical Data Sheet" by visiting our website at www.holderchem.net.
- All of the reported values in this brochure are given for indication purposes only. They are averages of several tests under laboratory conditions. In practice, these values may be significantly affected by the characteristics of raw materials and mixing conditions.

Statement of responsibility

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