Admixtures for Concrete Countertops

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The Concrete Countertop Institute

Concrete Mix Seminars

- How Concrete Works
  - Covers primary ingredients of aggregates, cement, water
- This seminar on Admixtures
  - Covers secondary ingredients such as pozzolans, fibers, admixtures and more

Access this and more at
www.ConcreteCountertopInstitute.com/mix-design

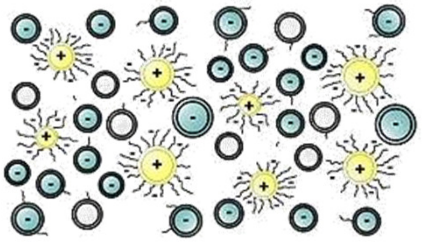
Further Resources

Precast Mix Design 101

- Includes mix formulas for 2 mixes that achieve compressive strengths of over 4000 PSI (27 MPa) in 1 day, 6200 PSI (42 MPa) in 3 days, and 8200 PSI (56 MPa) in 7 days
- Consists of videos, textbook, mix calculator: access link delivered instantly to your email inbox
- Priced at $99. **Currently 50% off for the Christmas 2013 sale.**

Concrete Admixtures

Ingredients that modify the cementitious binder



Why Use Admixtures?

- Reduce mix water
- Improve workability
- Change set time
- Reduce segregation
- Improve durability
- Increase strength
- Improve appearance
- Change color

Primary ingredients in concrete:

- Aggregates (sand and gravel)
- Portland cement
- Water

Secondary ingredients in concrete:

- Pozzolans
- Admixtures
- Fibers

Admixtures

- Modify only the cement paste
- Influence fresh and hardened characteristics
- Added to the mix
- Dosed proportionally by weight to the total dry weight of the binder (cement + pozzolan)

Example: 2% = 2 kgs admixture added to 100 kgs dry binder

Concrete Spices

Concrete Spices

- Mix design consistency and casting method dictate one admixture over another
- Different mix designs use different admixtures
- Different chemistries have different effects (mid-range WR vs polycarboxylate superplasticizer)
- Same chemistry, many different brands
- Ingredients, cement chemistry influence admixture effectiveness

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Admixture Companies

BASF The Chemical Company

Sika®

EUCLID CHEMICAL

SPECCO®

RITEKS

FRITZ-PAK CONCRETE ADMIXTURES

CHRYSO

Premiere Concrete Admixtures™

Master Builders Construction Chemicals Degussa Admixtures, Inc.

GRACE

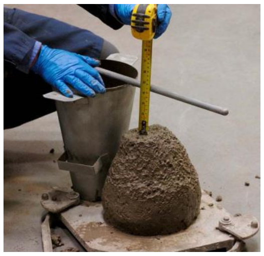
Workability Admixtures

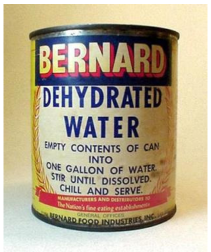
Admixtures that change the workability and consistency of the concrete

- Water reducers
- Superplasticizers
- Viscosity modifiers

Water Reducers

Increase slump without adding extra water





Water is an important ingredient that must be dosed carefully

It is not used like salt and pepper are to “season” the concrete to “taste”

Simply Adding Water:

- Reduces strength
- Increases porosity
- Increases shrinkage
- Alters coloration
- Decreases freeze-thaw resistance

Produces poorer quality concrete

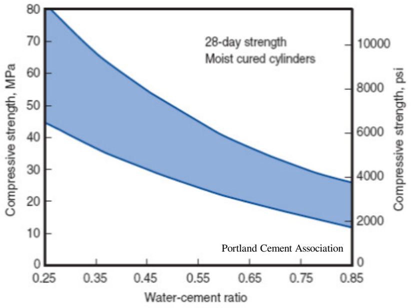


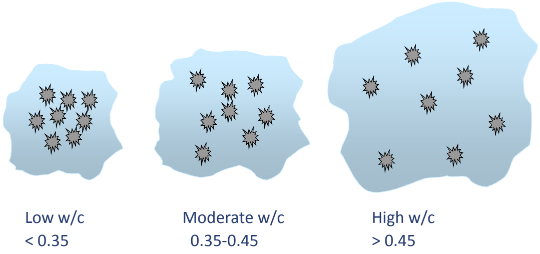
Fig. 1-17. Range of typical strength to water-cement ratio relationships of portland cement concrete based on over 100 different concrete mixtures cast between 1985 and 1999.

The Role of Water

Grape Kool-Aid®

– Too much water dilutes strength, color

The Role of Water



- More water = larger particle spacing
- More water = longer time to set
- More water = lower strength

Mix Design Considerations

A variety of mix styles can give a range of desired properties and looks.

Fluid

Stiff

Concrete Mix Styles

- Stiff
  - Characterized by zero-slump, stiff plastic state
  - Fresh concrete is easy to mold
  - Often uses all-sand type mix, but may also use an aggregate mix

Concrete Mix Styles

- Fluid
  - Characterized by high slump, or high flowability
  - Often uses graded aggregates with sizes ranging from sand to gravel
  - SCC, where very high flowability and long duration are desired

Self-Consolidating Concrete

- Highly flowable concrete that can spread under its own weight
- Spreads without segregation or excessive bleeding and without the need for significant vibration
- Flowability of SCC is measured in terms of spread instead of slump

Self-Consolidating Concrete

- **SCC is not made simply by adding a polycarboxylate superplasticizer to any concrete mix**
- SCC is achieved by designing a mix that has a low yield stress and an increased plastic viscosity
- Aggregate shape, sizing, gradation, and cement and water contents play key roles in achieving an SCC mix

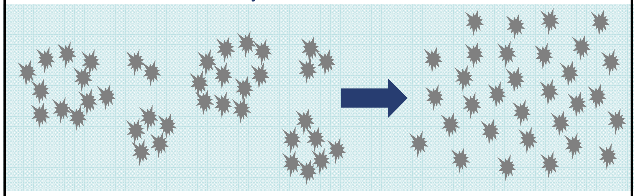
Improving workability

Water reducers:

- Add slump without adding water (and losing strength)
  - Constant w/c, increase in slump
- Reduce water content while preserving workability
  - Constant slump, decrease in w/c

Superplasticizer in action!

How Do They Work?



- Cement clumps together in water due to dissimilar surface electrical charges
- Cement clumps trap mix water
- Cement clumps behave like larger, rougher particles, increasing paste viscosity

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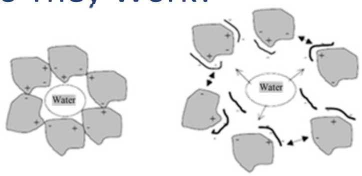
How Do They Work?



- Water reducers neutralize the attractive charge, freeing up trapped water
- Stronger superplasticizers cause particles to repel each other
- Polycarboxylates add a physical barrier (steric repulsion)

Water reducing admixtures

- Low and Mid optimized for flatwork
  - Add slump w/o adding water
  - Minimum effect on finishability
  - Designed for troweling
  - WR effects are short lived

- High range used more for precast
  - Achieve high slump with lower w/c ratio
  - Can be difficult to trowel
  - HRWR help stabilize concrete mix at high slumps
  - HRWR = Superplasticizer

Superplasticizers

- Primarily used for precast work
- Use for highly workable concrete with low w/c ratio
- Typically used when troweling won't be performed
  - can make concrete sticky
  - length of time it remains effective can vary
  - influence on set time can vary
- Plasticizing effect helps reduce bleeding

Superplasticizers

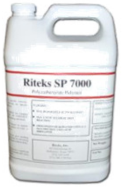
- Naphalene based
  - Fritz-Pak's Supercizer 5, 7
- Melamine based
  - Melment F-10

Excellent for stiffer mixes since these are not super-powerful

Polycarboxylate superplasticizers

- "Ultra-plasticizers"
- Often used for SCC, where very high flowability and long duration workability are desired
- SCC often also uses viscosity modifiers
- Not meant for troweling

Riteks SP 7000 is versatile and works in GFRC, SCC and vibrated wet-cast concrete



Tips for using superplasticizers

- Start low and gradually add *known* quantities of superplasticizer to the test mix
- Premixing the superplasticizer into the mix water permits rapid dissolution and even distribution of the superplasticizer
- Good starting dose for precast: 0.25% to 0.5%

Tips for using polycarboxylates

- Can take 2+ minutes of mixing to become fully effective
- Work best when used with viscosity modifiers
- Excellent for getting highly fluid concrete
- Effect varies with cement type and quality
- Easy to overdose and get segregation
- Other superplasticizer types are better for lowering w/c while maintaining a given workability (i.e. stiff, packable)

Viscosity Modifiers

- VMA
- Stabilizes cement paste
  - Reduces segregation
  - Reduces bleeding
  - Enhances consistency
- Does not affect flowability
  - preserves dynamic viscosity

Viscosity Modifiers

- Symptoms of segregation:
  - Lots of watery cream, excessive “bleedwater” (really overplasticized cement paste)
  - Mix starts out fluid and workable, but quickly gets “hard” and “sets up”. This is the aggregate settling out and self-compacting in the bottom of the mix bucket.
  - “Scum” layer has no sand or aggregate in it, and hardened surface shows prominent shrinkage cracks and crazing.

Viscosity Modifiers

Viscosity Modifiers

- Fritz-Pak's Slump Buster
  - Sodium carbonate ("soda ash")
  - Functions as a VMA at low doses (dash/sprinkle)
  - May accelerate setting and reduce strength at higher doses
- Commercial VMAs (Starvis 3003F, etc.)
  - Complex polymers
  - More potent, less effect on setting time or strength

Viscosity Modifiers

- Small amount preserves fluidity
- High dose creates thick, clay-like mix

Strength and Set Time Admixtures

Admixtures that change the setting time or increase the strength of hardened concrete

- Accelerators
- Retarders
- CSA additive
- Pozzolans

Accelerators

- Useful in colder weather
- Speed up set time, can increase the rate of early strength development
  - Increases reaction rate of tricalcium silicate (C3S) with water
- May reduce long term strength
- Can increase early shrinkage rates

Accelerators

- Calcium Chloride
  - Can lead to discoloration and mottling
  - May lead to corrosion in reinforcing steel
- Non-chloride accelerators (NCA)
  - Calcium diformate
  - Preferred, but not as potent or as cheap as CC
  - Always use NCA in concrete countertop mixes

Accelerators

CSA clinker additive

- Accelerates setting, strength gain
- Designed to work with portland cement
- Mix designs still need pozzolans to deal with CH
- NOT a pure cement on its own
  - Rapid Set CSA *is*

- Typical doses are 15% to 30% as cement replacement

Don’t be confused!

Buzzi Unicem “CSA” is NOT an actual CSA cement!

- From the website:

“CSA^{TM} is a hydraulic, cementitious binder high in Calcium Aluminum Sulfate Crystals. When used with Portland cement concrete, CSA^{TM} generates a strong cementitious matrix that enhances the physical and chemical properties of the mix.”

CSA Additive Considerations

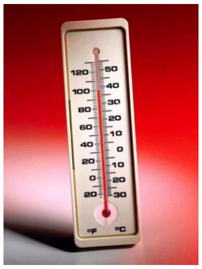
- Higher additive doses yield higher early strength
- Higher additive doses reduce setting time
- Set retardation done with ice and citric acid
  - Dose must be carefully moderated to reduce early strength loss
- **Cement binder mix design becomes more complicated**
- **I don’t recommend CSA additives. Just use 100% CSA cement.**

Very Fast Curing Cement

CSA Cement: Rapid Set

- A true cement, not an additive
- Use **in place of** portland cement, 100% replacement
- Can not use pozzolans (does not generate CH)
- Achieves 28 day strengths in about 24 hours
  - Typically 10,000+ psi (70 MPa) in 24-30 hours
- Simplifies mix design, compatible with most admixtures
- Uses citric acid as a set retarder

Heat



- Temperature of curing concrete affects strength gain

Concrete strength gain is about twice as fast at 90°F (32°C) than it is at 70°F (21°C)

Heat

- Hot water
  - Warms mix ingredients
  - Decreases setting time
  - Increases initial hydration rate
- Warm curing environment (80°F-100°F / 27°C-38°C)
  - Maintains/Increases hydration rate
  - Increased temperatures yield higher early strengths
  - Longer durations of warm curing yield stronger concrete

Retarders

- Useful in hot weather
- Slow down the set time by slowing down early hydration
  - Reduces reaction rate of tricalcium silicate (C3S) with water and slows growth of calcium hydroxide crystals
- Reduces early (1-2 day) strengths
- Can increase long term strength

Retarders

- Commercial retarders are predictable
- Table sugar is a retarder in portland cement but must be used very carefully
  - Typical dose: 0.1%
  - Maximum dose: 0.15%
  - Overdosing (>>0.2%) can “kill” concrete

Retarders

- Citric acid
  - 0.1% to 0.4% dose (CSA)
  - At 75°F (24°C), each 0.1% increase adds about 10-15 minutes of working time.
  - Increases strength of CSA based concrete
- **Best for CSA** (calcium sulfoaluminate) **cement**
- Use CAREFULLY with portland cement as it is very powerful (suggested dose 0.1% for +30 min)

Ice

- Temperature of mix ingredients affects setting time

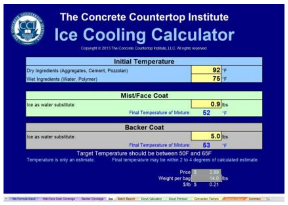
Concrete setting time is about twice as long at 50°F (10°C) than it is at 70°F (21°C)

Ice

- Use as part of mix water
  - Chilling concrete magnifies effects of chemical retarders
- Retardation only while concrete is cold
- No effect on strength, appearance after concrete warms up

Ice

- CCI mix calculators have ice calculations to predict final batch temperature
- No simple rules-of-thumb exist to safely predict ice amount vs final temperature



The Concrete Countertop Institute

Ice Cooling Calculator

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Initial Temperature

Dry Ingredients (Aggregates, Cement, Pozzolan): 92 °F

Wet Ingredients (Water, Polymer): 75 °F

Mist/Face Coat

Ice as water substitute: 0.9 lbs

Final Temperature of Mixture: 52 °F

Backer Coat

Ice as water substitute: 5.0 lbs

Final Temperature of Mixture: 53 °F

Target Temperature should be between 50F and 65F

Temperature is only an estimate. Final temperature may be within 2 to 4 degrees of calculated estimate.

Price $ 2.89

Weight per bag 14.0 lbs

$/lb $ 0.21

Mineral Admixtures

Pozzolans

aka Supplementary Cementitious Materials (SCM)

"Siliceous or alumino-siliceous materials that react with calcium hydroxide liberated during cement hydration to form additional cementitious materials"

- May be natural, manufactured or derived from waste products from industrial processes
- Include metakaolin, silica fume, fly ash, slag, and vitrified calcium aluminosilicates

Pozzolans

From left to right:

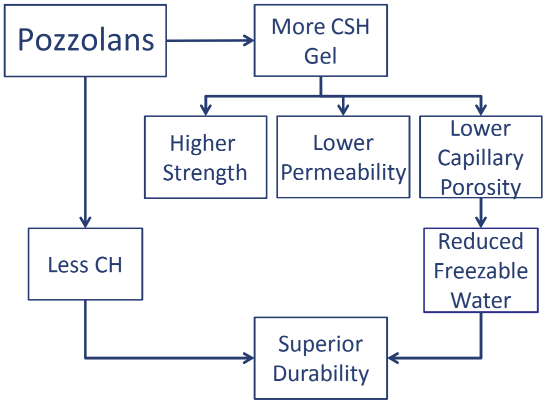
- Fly ash (Class C)
- Metakaolin
- Silica fume
- Fly ash (Class F)
- Slag
- Calcined shale

Pozzolans

- Water + cement = calcium hydroxide
- Pozzolans consume calcium hydroxide
- Pozzolanic reaction produces CSH gel

- Treated like cement, pound for pound
- Generally used as a cement replacement

- Take time to react
- Different pozzolans have different reactivities



Pozzolans

More CSH Gel

Higher Strength

Lower Permeability

Lower Capillary Porosity

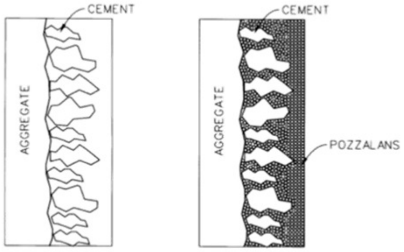
Less CH

Reduced Freezable Water

Superior Durability

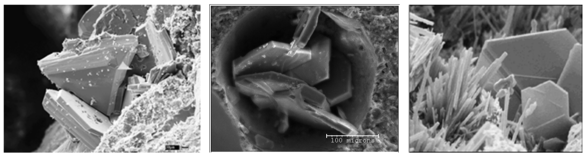
Pozzolans

- Act as micro-filler between cement particles and aggregates



Pozzolans

- Calcium hydroxide (CH) crystals tend to form on aggregate surface



- Pozzolans consume CH to form more CSH gel
- Increases bond and overall strength

Reasons for using pozzolans

- Improve long-term strength
- Improve/alter workability
- Reduce permeability
- Reduce bleedwater
- Reduce or eliminate ASR & efflorescence
- Reduces cement content
- Adds recycled material (depending on pozzolan)

Pozzolans and cement

- As a cement replacement:
  - Does not affect paste volume
  - Does not affect admixture dosage
  - Included with cement when calculating w/c ratio
- Reduces cement volume so early strength is reduced (as compared to 100% cement)

Pozzolans and cement

- As an addition to cement
  - Paste volume increases
  - w/c affected
  - Admixture dosage changes
  - Higher early strength, but greater influence on mix properties
- Unreacted pozzolans behave as microfine aggregate

Pozzolan

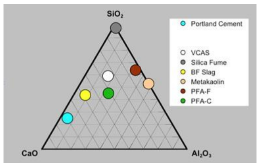
Most common pozzolans used in concrete countertops:

- VCAS
- Metakaolin

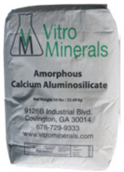
Factors affecting the effects of pozzolans

- Particle shape
- Particle size
- Chemical makeup
- Reactivity

- Dosage
- Curing conditions
- Temperature



Vitrified Calcium Aluminosilicate



(VCAS)

Meets ASTM C 618, C 1157, C 1240

- Produced using post-industrial fiberglass waste
- Nearly pure white
- Increases workability, reduces water demand
- Average particle size: 3-8 µm
- Good reactivity

Metakaolin

Engineered pozzolan from raw kaolin clay

Class N Pozzolan, ASTM C 618

- Metakaolin (calcined kaolin clay)
- Greatly improves concrete properties (strength, density, etc)
- Average particle size: 2-6 µm
- High reactivity, high early strengths
- Makes concrete sticky, reduces workability

Silica Fume

ASTM C 1240

Silica fume – exhaust gas residue resulting from the production of silicon-containing alloys in an electric-arc furnace

- Dark gray or white
- Average particle size: 0.1 to 1 µm
- High reactivity, high early strengths
- Greatly improves concrete properties (strength, density, etc)
- Makes concrete sticky, significantly reduces workability

Fly Ash

Ash from coal fired power plants

ASTM C 618

- Class F – fly ash with pozzolanic properties
- Class C – fly ash with cementitious and pozzolanic properties
- Small, glassy beads. Average particle size: 10-30 µm
- Cheap, mostly landfilled
- Slow reactivity

Ground Granulated Iron Blast-Furnace Slags

Slag (GGBFS) is a glassy, granular material left over from the production of iron and steel. As a fine powder it has cementitious and pozzolanic properties.

ASTM C 989
- Grade 80: low activity index
- Grade 100: moderate activity index
- Grade 120: high activity index

- Improves concrete strength, adds workability
- Low reactivity, slower set time, strength gain
- Greening (or blue) is possible from iron and manganese sulfide compounds in slag

Effects on freshly mixed concrete

↓ Reduced → No/Little Effect ↑ Increased ↕ Varies	Fly ash	Slag	Silica fume	Nat. Pozzolans
Water Requirements	↓	↓	↑	↕
Workability	↑	↑	↓	↑
Bleeding and Segregation	↓	↕	↓	→
Air Content	↓	↕	↓	→
Heat of Hydration	↓	↓	↕	↓
Setting Time	↑	↑	→	→
Finishability	↑	↑	↕	↑
Pumpability	↑	↑	↑	↑
Plastic Shrinkage Cracking	→	→	↑	→

Typical Dosages

• Fly ash	
– Class C	15% to 40%
– Class F	15% to 25%
• Slag	30% to 45%
• Silica fume	5% to 10%
• Metakaolin	10% to 15%
• VCAS	15% to 20%

  - Dosages are as cement replacement, not as addition

Other Admixtures:

- Pigments
- Polymers
- Defoamers
- Air Entrainers
- Fibers

Pigments

Pigments

Changes the color of cement paste

- Dry powders
- Liquid suspensions
- Iron oxides
- Synthetics

Pigments

- Maximum total dosage 10%
- May be blended (e.g. brown = red+yellow+black)
- Must be compatible with portland cement
- Should be UV stable
  - Carbon black cannot fade from sunlight
- Some are heat sensitive
  - Synthetic yellows tend to have low heat tolerance: 200°-350°F
  - Synthetic blues and reds tolerance more: 450°-550°F
  - Metal oxides have highest tolerance: 2500°-3000°F

Pigments

- Dry pigments can sometimes streak or clump
  - Add pigments early in mixing along with superplasticizer
- Liquid pigments often have retarding effects
- Some synthetic pigments have plasticizing effects
- Higher doses can affect concrete workability and flowability

Pigments

- Liquid and dry pigments are dosed the same way
- Add pigments to mixer, not mix water
- Carbon black does not fade from sunlight
  - It tends to wash out over time, so it looks faded
  - Dry concrete always looks pale and washed out compared to sealed concrete

Polymer

Added to concrete to improve properties

- Increases flexural strength
- Increases tensile strength
- Decreases porosity
- Increases internal water retention
- Reduces bleeding

Polymer

Effects highly dependent upon:

- Type of polymer
- Polymer dosage
  - Expressed as polymer/cement ratio, (P/C) (by weight of solids)

Polymer

- Latex refers to water-based emulsion
- Many different types:
  - Natural rubbers (“real” latex)
  - SBR (styrene-butadiene rubber)
  - EVA (ethylene-vinyl acetate)
  - Acrylics (polyacrylic ester) (PAE)

Polymer

- Overlay materials often use EVA latex
  - EVA latex are water rewettable
  - Best for adhesion, low cost
  - PS/C often 10% or 20%

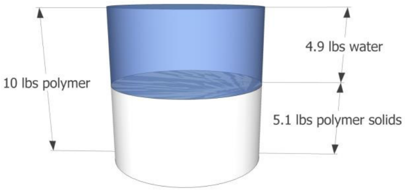
- Bonding agents can be EVA, SBR, others

Polymer

- GFRC uses specialized acrylic latex
  - Primary role is for moisture retention/curing aid
  - Good adhesion, excellent flexural strength
  - Non-rewettable (can't be dried into a powder)
  - 7 day strength depends on minimum 5% polymer solids dose; 6% is preferred for good finish
  - Forton VF-774 is recommended GFRC polymer

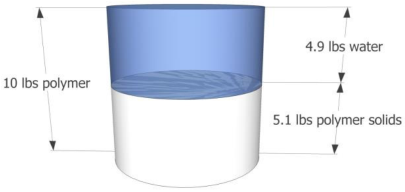
Polymer

- Liquid polymers have various polymer solids contents
- Forton VF-774 GFRC polymer is 51% solids



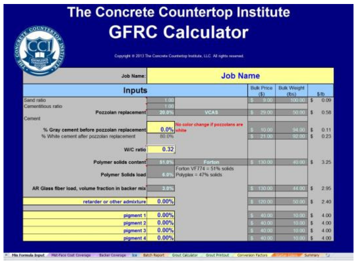
Polymer

- The solids portion is what matters
- The liquid portion counts as part of the mix water
- GFRC requires a 5% to 7% polymer solids loading



Polymer

- CCI's GFRC mix calculator deals with water in the polymer



The Concrete Countertop Institute
GFRC Calculator

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Job Name: Job Name

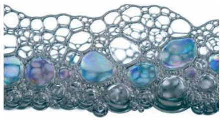
Inputs			Bulk Price ($)	Bulk Weight (lbs)	$/lb
Sand ratio	1.00		$ 9.00	100.00	$ 0.09
Cementitious ratio	1.00				
Pozzolan replacement	20.0%	VCAS	$ 29.00	50.00	$ 0.58
Cement					
% Gray cement before pozzolan replacement	0.0%	No color change if pozzolans are white	$ 10.00	94.00	$ 0.11
% White cement after pozzolan replacement	80.0%		$ 21.00	92.00	$ 0.23
W/C ratio	0.32				
Polymer solids content	51.0%	Forton	$ 130.00	40.00	$ 3.25
Polymer Solids load	6.0%	Forton VF774 = 51% solids Polyplex = 47% solids			
AR Glass fiber load, volume fraction in backer mix	3.0%		$ 130.00	44.00	$ 2.95
retarder or other admixture	0.00%		$ 120.00	50.00	$ 2.40
pigment 1	0.00%		$ 40.00	10.00	$ 4.00
pigment 2	0.00%		$ 40.00	10.00	$ 4.00
pigment 3	0.00%		$ 40.00	10.00	$ 4.00
pigment 4	0.00%		$ 40.00	10.00	$ 4.00

Defoaming Agents

- Help reduce formation of foam during mixing
- Do not make air disappear
- Can significantly reduce pinholes and air bubbles in concrete
- Most effective in flowable concrete
- Negligible effect in stiff concrete

Defoaming Agents

- Isopropyl alcohol
- Tri-n-butyl phosphate
- Commercial defoamers

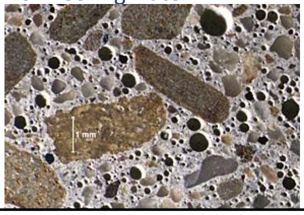


- Effectiveness, dosage, safety all vary

- Small amounts are very effective
- Added to the mix water to prevent foam formation
- Do not use with air-entrained concrete

Air Entrainers

- Create millions (billions?) of microscopic bubbles throughout the cement paste
- Empty air voids act as pressure relief caused by the expansion of freezing water



Air Entrainers

- Increased freeze/thaw resistance
- Increased workability
- Increased cohesion, stickiness
- Decreased bleeding and segregation
- Decreased strength (increasing air content by 1% decreases compressive strength by 2%-6%)

- Typical entrained air content is 4% to 6%

Air Entrainers

- Only necessary where concrete is subjected to repeated freezing and thawing
- Concrete must still be well cured, achieve a minimum compressive strength of 4500 psi (30 MPa), a w/c ratio below 0.45, and be wet cured for at least 7 days above 50℉ (10℃) and dried for 30 days before freezing.

Fibers

Fibers

- Boost flexural (bending) strength
- Boost tensile strength
- Boost toughness (chip resistance)
- Increase fracture resistance

Fibers

- Fibers **DO NOT** replace structural reinforcement
  - True for conventional concrete, GFRC is different
- Not all fibers add strength or toughness
- Fibers provide strength benefits after the concrete cracks
- Fibers *do* provide crack control (size and spacing)

  - *If your client can't see a crack, is it really there?*

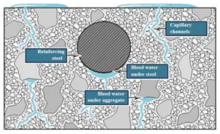
Fibers

Generally added to concrete as *plastic shrinkage control*, also known as **secondary reinforcement**

- This is different from structural reinforcement – that is primary reinforcement

- Matrix of fibers helps to stabilize the wet concrete and distribute the plastic shrinkage stresses so that large cracks are minimized or eliminated as concrete begins to harden

- The fibers keep the rocks from settling

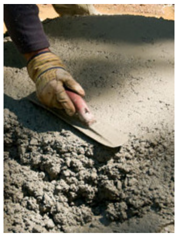


Fibers

Forms

- Monofilament
- Multifilament
- Fibrillated
- Macrofiber (large)
- Microfiber (small)

Fibers



Ordinary (mainly for flatwork)

- Polypropylene
- Polyolefin
- Nylon
- Polyester
- Cellulose
- Other natural (jute, sisal, coir, bamboo, etc)

Fibers



Structural

- Steel
- AR glass
- Carbon
- PVA (polyvinyl alcohol)
- Aramid (Kevlar)

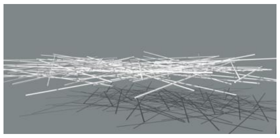
Fibers

Factors that effect fiber influence on concrete:

- Material, strength, stiffness
  - High strength, high modulus (stretchiness) fibers withstand higher loads better and stretch less
- Diameter, length, shape
  - Longer fibers are more effective (more surface area, better pullout resistance)
- Dosage, dispersion, orientation
  - Higher doses are more effective

Fibers

- Fiber orientation affects strength and effectiveness
  - (2D orientation from compaction rollers vs 3D from wet casting)



2D orientation after compaction

3D random orientation

Fibers in GFRC

- AR Glass fibers/chopped roving
- Typical lengths 13mm to 19mm in premix
- 19mm fibers yield stronger concrete

Fibers in GFRC

Fiber dose based on *total weight* of all materials

- Effective dose: 3%
  - 3 kg fibers added to 97 kg of mist coat to make 100 kgs of GFRC backer

Recommended Precast Admixtures

- Polycarboxylate Superplasticizer (Riteks SP7000)
- Viscosity Modifier (Fritz-Pak Slump Buster)
- Retarder (citric acid)
- Pozzolan (VCAS)
- Fibers (Nycon REC-15 8mm PVA or NEG 13mm (1/2") AR glass)

- Visit www.ConcreteCountertopInstitute.com/store and click on Mix Ingredients category

Recommended GFRC Admixtures

- Polycarboxylate Superplasticizer (Riteks SP7000)
- Viscosity Modifier (Fritz-Pak Slump Buster)
- Retarder (citric acid)
- Pozzolan (VCAS)
- Fibers (NEG AR glass 19mm (3/4"))
- Polymer (Forton VF-774)

- Visit www.ConcreteCountertopInstitute.com/store and click on Mix Ingredients category

Questions & Resources

Precast Mix Design 101

- Includes mix formulas for 2 mixes that achieve compressive strengths of over 4000 PSI (27 MPa) in 1 day, 6200 PSI (42 MPa) in 3 days, and 8200 PSI (56 MPa) in 7 days
- Consists of videos, textbook, mix calculator: access link delivered instantly to your email inbox
- Priced at $99
- **Christmas 2013 SALE: Save 50%! Just $49.50!** Ends December 31, 2013 at 11:59pm Eastern.

- **Type this into your browser now: bit.ly/mixdesign2013**
  - **Or check your inbox for a one-click link.**

You will also receive a link in a later email to access this seminar's recording.

Contact: info@concretecountertopinstitute.com or 888-386-7711

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