



TYTRO[®]

Shotcrete System



ADVANCED. EFFICIENT. RELIABLE.

GCP UNDERGROUND SOLUTIONS

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TYTRO® SHOTCRETE SYSTEM

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ADVANCED FULL SHOTCRETE SYSTEM

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- Specialty Shotcrete Admixtures

- High-Range Water-Reducers
- Rheology Modifiers
- Hydration Control
- Air-Entraining

- Rheology Control

- Set Accelerators

- Fiber Reinforcement

EFFICIENT SHOTCRETE MIXES

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- Customized Mix Design

- Mix Optimization

- Improved Performance

RELIABLE TECHNICAL SUPPORT

5

- Site Visits & Training

- Quality Control Monitoring

A GLOBAL TEAM

Focused on providing our customers the highest level of performance and support

Built on talent, technology, and trust, GCP Applied Technologies is a leading global supplier of specialty construction chemicals and building materials. GCP provides innovative materials, systems and services that strengthen, enhance and protect structures.

GCP's comprehensive portfolio of solutions for the mining and infrastructure tunneling industries includes admixtures for shotcrete and concrete, injection technologies for ground improvement, and proprietary fiber reinforcement systems.

From the smallest to the largest, the simplest to the most complex underground projects, every project has its own individual challenges. By combining their technical expertise in shotcrete mix design optimization, on-site monitoring systems, and ground control technologies that are right for the project, our technical specialists around the world work to provide solutions for our customers to overcome their geotechnical challenges.



ADVANCED. EFFICIENT. RELIABLE.

GCP Applied Technologies introduces its state-of-the-art **TYTRO® Shotcrete System** to help customers reduce shotcrete operating costs, minimize excavation downtime, achieve desired technical performance, and meet the highest safety standards.

Our field teams provide support to help our customers integrate our advanced TYTRO® technologies into their shotcrete production and ground support operations for increased safety, efficiency, and productivity.

- > **Advanced full shotcrete system for ground support** – Our complete system has been formulated to achieve faster early strength, enhanced bond to rock substrate, larger thickness in one pass, and minimum rebound and dust.
- > **Efficient shotcrete mixes for optimal installed cost** – Our world-class laboratory resources and technical specialists acknowledge the need in customized mix designs to achieve performance requirements and ensure that our customers get the most technically suitable, optimized, and cost-effective mix designs for every project to meet the target performance.
- > **Reliable technical service and support** – Independent of location, we deploy the best mix of our global and field service team to assist our customers worldwide in optimizing their mixes as well as providing site support and training.

Delivering LOWER INSTALLED COST, reduced cycle times and superior performance.

TYTRO® SHOTCRETE SYSTEM:

- > High-Range Water Reducers –**TYTRO® WR**
- > Hydration Control – **TYTRO® HC**
- > Air-Entraining – **TYTRO® AE**
- > Rheology Modifiers – **TYTRO® RM**
- > Rheology Control – **TYTRO® RC**
- > Set Accelerators –**TYTRO® SA**
- > Fiber Reinforcement – **STRUX®**



SPECIALTY SHOTCRETE ADMIXTURES

TYTRO shotcrete system offers specialty shotcrete admixtures that are formulated for shotcrete mixes to achieve high performance characteristics and meet project requirements. Due to their synergetic benefit, they are formulated to be used together.

SET ACCELERATORS

TYTRO® SA latest generation of high-performance, alkali-free set accelerators are specifically formulated to provide high early strength at low dosage rates and improve productivity by shortening the time of setting without compromising long-term strength and durability.

Superplasticizers

TYTRO® WR high-range water-reducing admixtures for shotcrete provides superior flow, prolonged pot life, excellent plasticity, and maximize strength performance by allowing lower water-to-cementitious materials ratio (w/cm).

Hydration Control

TYTRO® HC cement hydration control admixture allows optimal logistical operations by extending the working life of shotcrete up to 72 hours.

Air Entraining

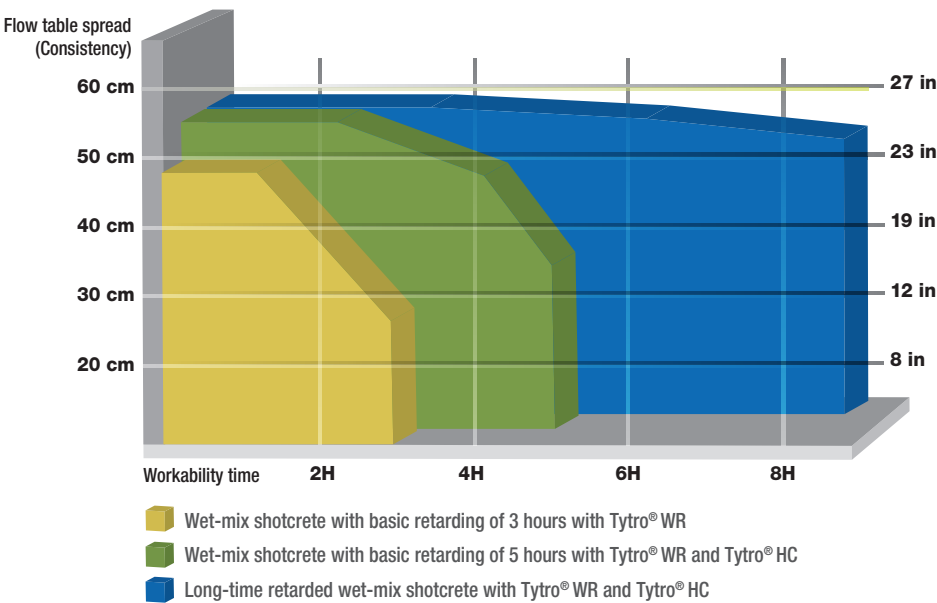
TYTRO® AE is an air entraining admixture for use in shotcrete mixes to protect against damage from freeze/thaw cycles.

Rheology Modifier

TYTRO® RM rheology modifying and mix-enhancing admixtures are formulated to improve the pumpability and sprayability of the shotcrete mix.

LOWER DOSAGE RATE

REDUCED EXCAVATION DOWNTIME
AND HIGH EARLY STRENGTH



ADVANTAGES OF TYTRO® SA

- > Efficient dosage rate – Highly active formulation for low dosages
- > Reduced excavation downtime – Increased adhesion and faster setting to allow for earlier finishing
- > Improved early strength – Without compromising later age strength
- > Reduced cycle times – Quicker setting action and increased layer thickness
- > Minimum material waste – Lower rebound and dust
- > Safer and healthier to handle – Non-alkaline formulation
- > Robust and easy to dispense – Liquid product; easily measured and dosed



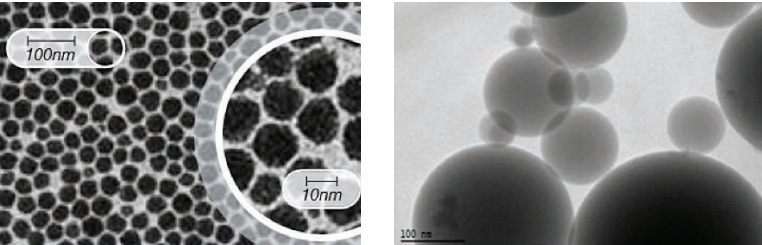
► RHEOLOGY CONTROL

TYTRO® RC innovative rheology control admixtures are designed to reduce our customers’ installed material cost when used as a replacement for silica fume or other pozzolanic materials.

TYTRO® RC products provide superior bond to rock substrate, faster strength development, enhanced sprayability and pumpability characteristics, and minimum rebound and dust in tunnels and underground mining shotcrete applications.

Featuring the latest in nanotechnology, TYTRO® RC products contain a liquid dispersion of discrete, spherical, uniformly distributed nanometric particles of amorphous silica for use in shotcrete.

TYTRO® RC vs. Traditional Pozzolanic Materials



TYTRO® RC VS SILICA FUME

Nanometric	Micrometric
Engineered Material	Industrial Waste
Pure and Amorphous	Containing Impurities
Liquid	Powder
Robust	Variable Quality
Easy to use	Difficult to Handle

LOWER INSTALLED **COST**

THICKER PASSES WITH
LESS REBOUND AND DUST

TYTRO® RC VS. SILICA FUME

- > Highly dosage-efficient – Very low dosage rates to meet performance specifications
- > Enhanced sprayability – Improved cohesion
- > Lower rebound and dust – Minimum material waste
- > Reduced cycle times – Larger layer thickness in a single pass
- > Faster early strength
- > Comparable later strength and durability – High resistance to water penetration due to reduced permeability
- > Safer and healthier to handle
- > Robust and easier to dispense and dose
- > More consistent quality
- > Easier to store – Free up silo space

✱ UP TO **60% LOWER COST**
THAN SILICA FUME

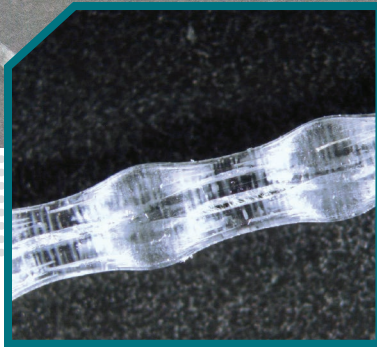
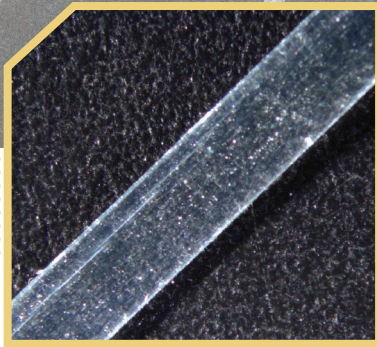
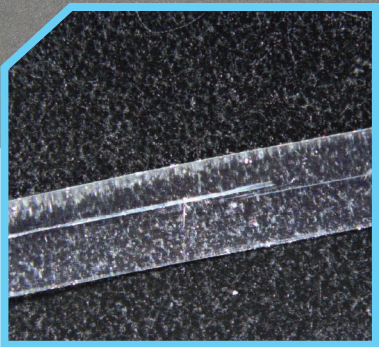
ENHANCED USABILITY

LONG-TERM DURABILITY AND SUPERIOR TOUGHNESS

FIBER REINFORCEMENT

STRUX® macro-synthetic fibers are high performing proprietary engineered copolymer fibers used as a replacement for steel fibers and wire mesh reinforcement in underground shotcrete construction.

STRUX® is added to shotcrete to provide toughness, impact, and fatigue properties. In addition to its superior crack control and resistance, STRUX® also eliminates corrosion issues or safety concerns associated with the use of steel fibers. Depending on the project requirements, STRUX® offers the following macro-synthetic fibers:



CHARACTERISTICS	STRUX® 90/40
Base Material	Polypropylene/ Polyethylene
Length	40 mm (1.57")
Specific Gravity	0.92
Tensile Strength*	620 MPa (90 ksi)
Modulus of Elasticity**	9.5 GPa (1,378 ksi)
Shape	Rectangular
No. Fibers per kg	180,000
Melting Point	160°C (320°F)
Ignition Point	590°C (1,094°F)
Packaging	Loose Fiber Bags

CHARACTERISTICS	STRUX® 85/50
Base Material	Polypropylene/ Polyethylene
Length	50 mm (1.97")
Specific Gravity	0.92
Tensile Strength*	580 MPa (84 ksi)
Modulus of Elasticity**	9.0 GPa (1,305 ksi)
Shape	Rectangular
No. Fibers per kg	83,000
Melting Point	160°C (320°F)
Ignition Point	590°C (1,094°F)
Packaging	Loose Fiber Bags

CHARACTERISTICS	STRUX® BT50
Base Material	Polypropylene/ Polyethylene
Length	50 mm (1.97")
Specific Gravity	0.91
Tensile Strength*	550 MPa (80 ksi)
Modulus of Elasticity**	7 GPa (1,015 ksi)
Shape	Tapered
No. Fibers per kg	60,000
Melting Point	160°C (320°F)
Ignition Point	570°C (1,058°F)
Packaging	Condensed Fiber Bags

*Measured at a strain rate of 10%/min.

**Elastic modulus is derived from a straight line between the stress-strain coordinates at 10% and 30% of the maximum strength of the fiber.

INTRODUCING STRUX® BT50

GCP introduces the latest generation **STRUX® BT50** macro-fiber featuring a patented design developed for underground shotcrete applications. Its advanced packaging condenses the fibers in an aligned format, improving dispersion in the shotcrete mix compared to traditional loose fiber packaging.

The improved dispersion resulting from the aligned fibers reduces balling, and the alignment of the fibers prevents individual fibers from curling and becoming tangled prior to use, thereby enhancing placement.

STRUX® BT50 vs COMPETING MACRO-SYNTHETIC FIBERS

- > Low cost per Joule
- > Higher post-crack energy absorption at equal dosage rate
- > Superior dispersion properties
- > Reduced balling
- > Lower impact on slump

STRUX® BT50 vs STEEL FIBERS

- > **More dosage-efficient** – Low dosage rate required to meet 450 Joule Q-Chart specification
- > **Long term durability** – Corrosion free
- > Reduced cycle times
- > Superior dispersion
- > Safer and lighter to handle
- > **Reduced fire damage** – Lower spalling risk
- > Reduced wear on concrete pumps and hoses

STRUX® BT50 vs STEEL MESH

- > Reduced cycle times
- > Lower labor and installed material cost
- > Enhanced Safety



SAFE EFFICIENT OPERATIONS

MIX DESIGN AND OPTIMIZATION

We help our customers achieve safe and efficient shotcrete operations by combining our market-leading technologies and mix design and optimization skills with hands-on technical application expertise.

Customized Mix Design

Every project has different requirements, challenges, and specifications. Our world-class laboratory resources and technical specialists acknowledge the need for customized mix designs to achieve performance requirements and ensure that our customers get the most technically suitable, optimized, and cost-effective mix designs for every project.

Mix Optimization

Our customers achieve major productivity gains and cost savings through advanced, tailored mix solutions delivered by a team of world-class technical specialists and a suite of advanced resources, ranging from rapid diagnostic tools to on-site monitoring systems.

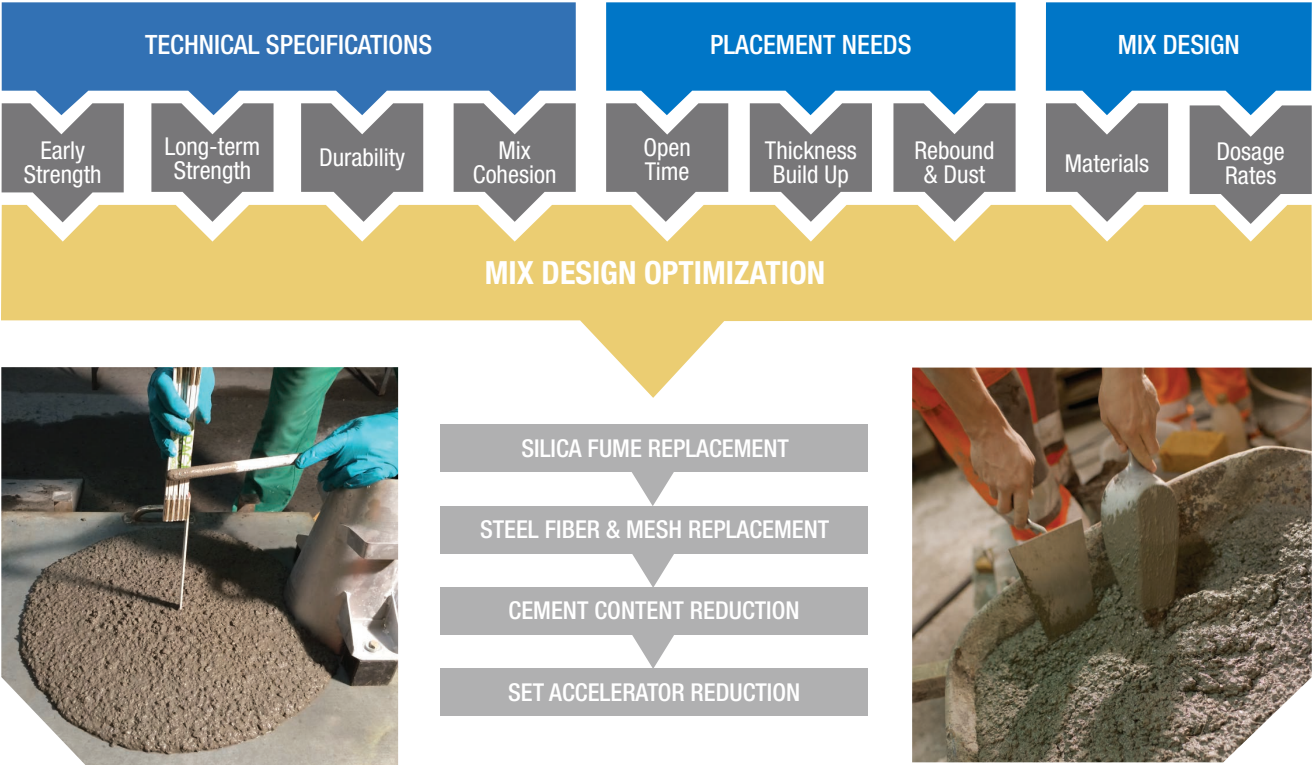
Improved Performance

Admixtures offered in the TYTRO® system have highly active formulation and require low dosages to improve performance. Due to their synergetic benefit, they are formulated to be used together. They provide high plastic and hardened properties and reduced cycle times. They are highly cost-effective and environmentally-friendly.

ACHIEVING SHOTCRETE EXCELLENCE

TYTRO® Shotcrete Excellence Program

Our TYTRO® Shotcrete Excellence Program (TSEP) is our unique mix design and optimization program for shotcrete operational excellence. Faced with rapidly growing demand from our customers for help in enhancing both mix and operational performance, we have developed our own competence center through the TYTRO® Shotcrete Excellence Program to play an active role in shotcrete mix development for customers.



Through our TYTRO® Shotcrete Excellence Program, we help our customers achieve rapid, significant, measurable improvements in productivity and performance across mix design optimization:

- > *reduce shotcrete operating costs*
- > *minimize excavation downtime*
- > *reduce rebound and dust*
- > *meet highest technical and safety standards*

For more information on our TYTRO® Shotcrete Excellence Program please contact us by email at:
Shotcrete.excellenceprogram@gcpat.com

CONCRETE TECHNOLOGY EXPERTISE

Our technical specialists combine the comprehensive concrete technology understanding with strong technical application expertise in the mining and infrastructure tunneling industries worldwide.

Our field teams serve hundreds of underground construction customers from leading mining companies to top tunneling contractors and have deepened our expertise in solving our customers' toughest ground control challenges from diagnosis to implementation.



Training and Education

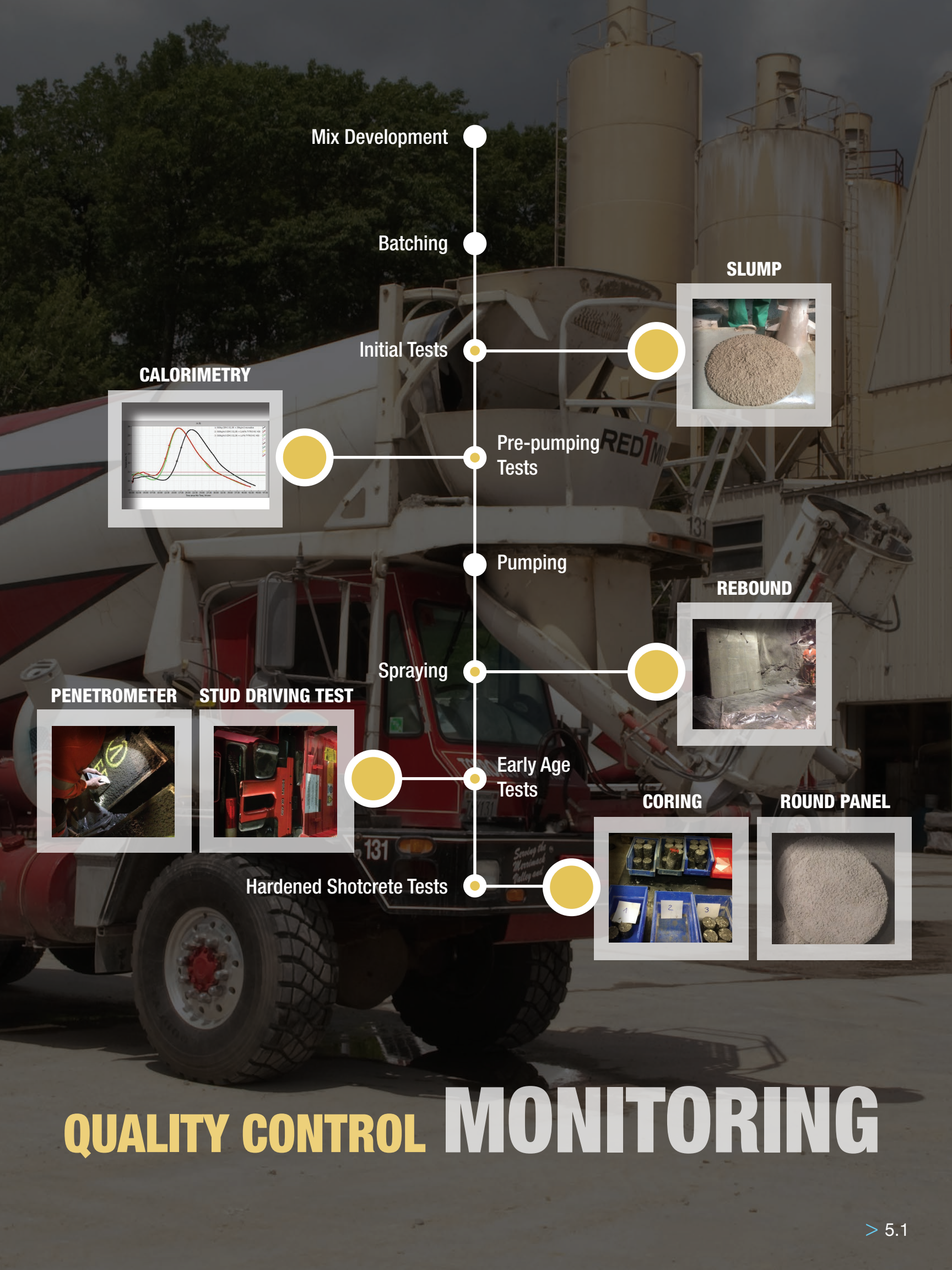
GCP offers a variety of approaches to learning, from tailored, on-site product training to online webinars. Our team integrates insights from years of experience and knowledge into our curricula, and helps our customers translate their learning into their daily operations for lasting shotcrete performance improvement.

Site Support

Our field teams work on-site with customers to help them move beyond mix recommendations and trials—to achieve performance improvement and measurable productivity results. They work side-by-side with our global industry and technology experts, and partner closely with our customers to help them produce results—rapid, significant, measurable improvements in productivity, cost, quality, and safety. Our support offering is flexible and designed to meet specific customer needs.

Quality Control

Our field technical specialists work intensively with customers to obtain lasting and substantial performance improvement through the implementation and monitoring of comprehensive quality control programs. They offer a suite of advanced tools ranging from rapid early strength diagnostic tools to on-site calorimetric systems for optimal hydration control.



Mix Development

Batching

SLUMP

Initial Tests

CALORIMETRY

Pre-pumping Tests

Pumping

REBOUND

Spraying

PENETROMETER

STUD DRIVING TEST

Early Age Tests

CORING

ROUND PANEL

Hardened Shotcrete Tests

QUALITY CONTROL MONITORING



GLOBAL

UNDERGROUND CONSTRUCTION TEAM

Many miles of tunnels span the globe.
So does our team. Whatever your underground
construction needs, we have you covered.



ADVANCED. EFFICIENT. **RELIABLE.**

gcpat.com | North America Customer Service: 1-877-4AD-MIX1 (1-877-423-6491)

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Printed in U.S.A. TYT-001-0316 CP0025 CD/PDF



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