TB-1301 — RECOVER® Hydration Stabilizer Applications and Performance Review Technical Bulletin

Introduction

This bulletin discusses the performance of RECOVER® hydration stabilizer for set and temperature control applications in concrete or mortar mixes. Project examples are also provided. RECOVER® complies with ASTM C494 as a Type D retarder.

Project Applications & Benefits

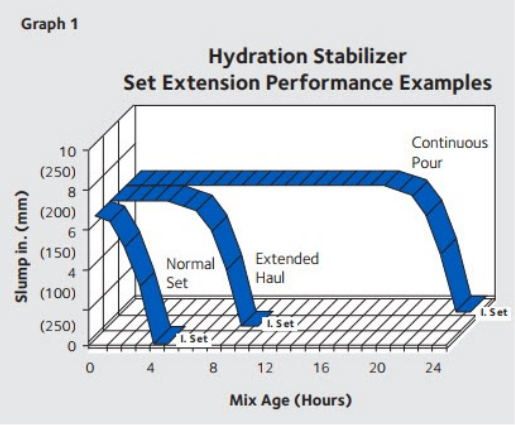
- Permits long hauls to remote sites
- Allows for extended truck discharge times
- Reduces need for portable batch plants or on-site cement addition
- Controls temperature increase
- Provides predictable extended set for continuous placement on mass concrete and tremie projects

What is a Hydration Stabilizer?

Hydration stabilizers are advanced set retarders. While conventional set retarders enjoy widespread use to slow concrete set times, on many projects additional set control is needed. Hydration stabilizers are formulated to provide this extended control, ranging from a few hours of delayed set for long haul or delayed placement situations, to over 30 hours for large continuous pour projects.

With RECOVER® hydration stabilizer, the window of plasticity can be extended in a predictable manner to bring new flexibility and opportunity to a variety of projects.

Graph 1



How Does RECOVER® Work?

Organic chelating agents within the formulation seek and coat the hydrating cement grains. Water and ions needed for further hydration are blocked to completely suppress cement surface activity. With the hydration reaction suspended, set is postponed and the mix retains slump, plasticity, air content, and stable temperature for the duration of the set extension. Eventually the stabilizer is chemically consumed, (the total set delay is a function of the dosage rate), normal hydration activity resumes and the mixture sets with superior ultimate strength performance.

The primary difference between hydration stabilizers and conventional retarders is the range of control over the variety of hydration reactions at the surface of the cement grain.

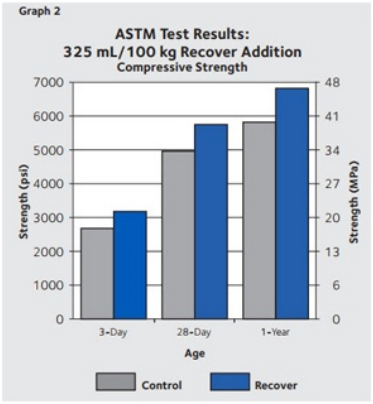
Conventional Retarders

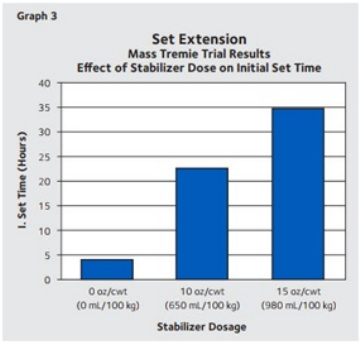
Conventional retarders act on some of the hydration reactions to provide moderate slump retention and set delay. When used at high dosage rates, set extension can be unpredictable.

Over-retardation may result.

Hydration Stabilizers

Hydration stabilizers suppress all of the major hydration events to provide complete, predictable control over the setting process. Once a dosage rate is determined for a mixture, and particular set of materials, set times show little deviation.



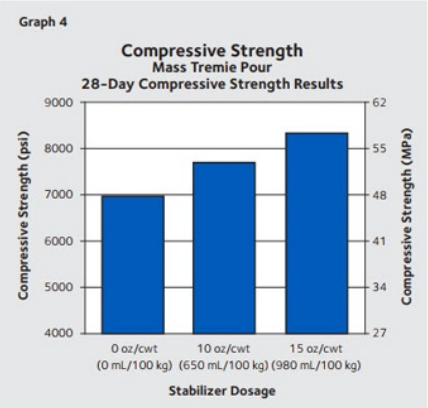


Increased Strength and Quality

Hydration stabilizers are similar to conventional retarders with respect to the increased strength and quality that results from their use. The dispersion and set delay provided by the stabilizer produce a superior microstructure within the concrete matrix. Concrete made with RECOVER® exhibits 28 day compressive strengths that exceed similar non-RECOVER® mixes by 300 to 1,500 psi (2 to 10 MPa). ASTM test results are provided(Graph 2). A field example of this strength increase is provided in pre-job test results (Graph 4) from a Florida Power mass tremie project detailed in this bulletin.

Air Entrainment and Durability

Hydration stabilization enhances the efficiency of air entrainers by 10% to 20%. Air entrainer dosage rates may need to be scaled back proportionately. Experience shows that air stability is greatly enhanced in concrete containing RECOVER ® hydration stabilizer. In most extended haul situations, excessive air loss will not occur.



Project Examples

Example 1

10,000 yd^3 (7,600 m^3) Extended Set Mass Tremie Concrete Placement

Florida Power needed to pour a 10,000 yd^3 (7,600 m^3) concrete mat, 20 ft (6 m) beneath the surface of a 90°F (32°C) body of water to serve as the base for a new cooling tower. This major mass concrete tremie placement required a concrete mix meeting the following criteria:

1. Maintain plasticity and extended set for 24 to 30 hours in a 90°F (32°C) environment.
2. Obtain physical properties—pumpability, slump life, and strength equal or better than normal setting concrete of the same cement factor.

The extended set was required to insure that the concrete surrounding the immersed end of the tremie line would remain plastic to allow repositioning over the 30 hour placement period.

PcCal Used For Precision Set Time Determination

The concrete supplier, Florida Mining & Materials, worked closely with GCP representatives using PcCal, a PC-based calorimetry system used by GCP to automatically monitor and determine set performance on trial mixes, with increasing RECOVER® dosage rates. The PcCal system generates precision set time information that allows increased accuracy in the final dosage selection. PcCal was also used as a quality assurance tool during the mass pour to verify set performance. Mix design and performance results are provided below:

Cement	564 yd^3	(335 kg/m^3)
Fly ash	141 yd^3	(85 kg/m^3)
Coarse agg.	1,456 yd^3	(865 kg/m^3)
Sand	1,250 yd^3	(740 kg/m^3)
Water	329 yd^3	(195 L/m^3)

AEA	5 oz/yd^3	(150 mL/m^3)

Based on the set delay information gained from pretesting(Graph 3), a RECOVER® dosage of 12 oz/100 lbs (780 mL/100 kg) of cementitious material was used in the mix to provide an average set extension of 26 hours.

Project Success

The extended set mass tremie placement was successful:

- No trucks were rejected throughout the entire job.
- Multiple samples were monitored for set time throughout the pour duration and the results showed that all mixes set between 26 and 30 hours.
- All strength tests exceeded project requirements.

Example 2

Extended Set Bedding Mortar

The Army Corps of Engineers RCC (Roller Compacted Concrete) Dam project in Washington State required extended set performance of up to 8 hours in the 2,400 yd^3 (1,800 m^3) of bedding mortar applied between lifts of RCC concrete.

After pretesting, a RECOVER® dosage of 15 oz/cwt (980 mL/100 kg) was selected for use in the bedding mortar mix [500 yd^3 (300 kg/m^3) cement, 100 yd^3 (60 kg/m^3) fly ash + sand + water] to provide the following hydration control benefits:

- Slumps maintained at 8 in. (200 mm) over the 7–8 hour hold period.
- Stable mortar temperatures, despite high ambient temperatures.
- Set extension allowed flexibility to use partial truckloads when needed and save remainder for use later in the day without sacrificing quality.

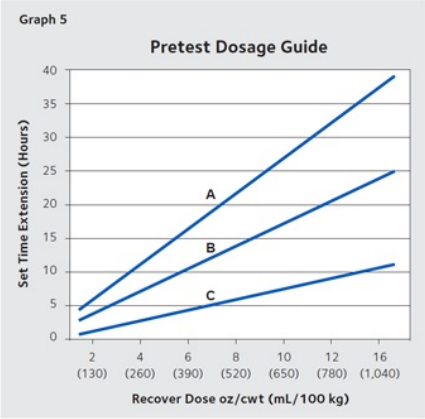
Example 3

Long Haul Project

In Arizona, 16,000 yd^3 (12,000 m^3) of concrete will be supplied for the construction of the Mead-Phoenix transmission line of the Boulder Dam Salt River Project from a location in excess of 100 miles (160 km) from the placement site. Pre-job tests show that a RECOVER® dosage of 8 oz/cwt (520 mL/100 kg) provides the additional 4 hours of set extension required for the project. Project engineers and placement crews are pleased with the RECOVER® 's ability to deliver concrete with workable slumps, stable air and controlled temperature to the remote site after a haul time in excess of 3 hours.

RECOVER® Dosage Selection

Most cementitious mixtures can be stabilized with RECOVER® to achieve the desired set extension. The dosage for a particular concrete mix will depend on the chemical admixtures, concrete materials and mix designs used, the concrete temperature, the quantity of concrete being treated, and the stabilization time required. Pretesting of mixes with RECOVER® is required to establish proper dosage rates. GCP sales and technical representatives are available to assist with RECOVER® dosage selections to meet the hydration stabilization needs of the project.



Graph 5 provides information to make initial dosage selections for pre-job testing. Lines A & B represent a typical dosage range for concrete mixtures in moderate temperature conditions.

Line C provides a general dosage guide for mortar mixtures and concrete used in hot weather situations.

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