



Disposal of Shore Pac Slurry

Introduction

The use of synthetic polymer slurries as replacements for Bentonite and other minerals has become widespread. Key attractions of polymer slurries have been their degradability and low environmental impact, which has translated into reduced disposal difficulty for contractors.

The drilling slurry Shore Pac manufactured by CETCO Construction Drilling Products, to be used on a drilled shaft Project is not a hazardous waste, nor does it pose any threat to the waters of the State.

Is Polymer Slurry Toxic?

A Shore Pac slurry system can be classified as an acryl amide which falls under the general classification of a polyacrylamide. The acrylic contents of the molecule are non-hazardous and non-toxic. Shore Pac's chemical classification is listed in the U.S.A. EPA TSCA manual under code 25085-02-3. Shore Pac is identified as a non-toxic substance as defined by the U.S.A. Environmental Protection Agency. Shore Pac™ is approved for use by The Federal Highway Administration, (FHWA), and is used in States throughout the nation. The Method for disposing the drilling slurry Shore Pac on this Drilled Shaft Project has been listed within this correspondence.

Is Polymer Slurry Biodegradable?

Synthetic polymers are not readily biodegradable. Biodegradable means that slurry made from a biodegradable polymer will be subject to spoilage with breakdown of the slurry. Polymer slurry is not subject to spoilage. Shore Pac slurry is chemically degradable. Chemically degradability relates to chemical oxygen demand, or COD, and is the degrading of the polymer through interaction with another non-living substance. Shore Pac slurry is chemically degradable on demand by treatment with the chemical oxidizing agent Slurry Buster.

The Shore Pac Polymer slurry contacts the surrounding soil and groundwater during construction of cast-in-drilled-hole piling but does not migrate into the surrounding soil of the excavation due to a gel membrane that forms along the sidewalls of the borehole. This membrane cohesively binds the soils together forming temporary glue, which seals off the vertical liquid slurry column. The product Shore Pac being proposed for use as drilling slurry for the foundation project is not harmful to the environment.

Is Polymer Slurry able to be Broken Down?

At the end of the job there is usually a need to dispose of a quantity of polymer slurry which remains from the last borehole or excavation. The Shore Pac slurry is degraded by a variety of mechanisms. The polymer is broken down or removed from the slurry during use in drilling or excavating. The mechanisms which cause this include adsorption (bonding) onto earth soils and chemical reaction with alkalis and contaminants such as calcium in the slurry, the make-up water or the groundwater.

Shore Pac slurry fluids are non-toxic and are readily degradable upon completion of a slurry job to facilitate disposal. Upon completion of the project, any remaining **Shore Pac** is broken down with the chemical oxidizer (**Slurry Buster**) the most common oxidizer for this purpose.

The Slurry Buster solution is added to the Shore Pac slurry at a rate of 3-5 gallon per (3,000 gallons) of slurry to be treated. After the breaker is added, the slurry is circulated using the pumps on-site to ensure complete oxidation of the polymer molecules. This is accomplished by pumping it back into a holding tank.

The Slurry Buster destroys the active ingredients within the polymer and at the same time breaks the polymer, reverting it back to basic water. The end result of Shore Pac decomposing after its encounter with (**Slurry Buster**) is not a harmful substance.



Is Polymer Slurry Disposable?

Treated slurry fluids are environmentally safe when handled as directed. When breakdown is complete, **all that remains is trace acrylate molecules and water**. This is often safely discharged or simply spread on the ground to evaporate or used in dust control.

Additionally, polymers with the same chemical base as found in Shore Pac are used in potable water treatment as flocculants, with federal government clearance. They are widely used throughout the world as coagulants and flocculants used for environmental and process improvement, acting through solid/liquid separation. They are used in paper manufacturing, wastewater treatment, mineral and oil extraction, soil conditioning and as thickeners in cosmetics. As such, they have many regulatory approvals around the world, such as for drinking water treatment, indirect additives for food-contact paper and for other specific uses. Municipal sewage sludge, which has been polymer-treated for de-watering, is widely applied to agricultural land.

CETCO certifies that Shore Pac slurry is not harmful to the environment and is safe for disposal.



Rock Sockets & Shore Pac Slurry

Drilled, cast-in-place, reinforced concrete straight sided drilled shafts installed by the slurry displacement method with or without temporary casing and a rock socket shall maintain the slurry level within the pier hole so as to allow a sufficient height of static slurry above the static water level. This is in order to maintain excavation stability and in accordance with the slurry supplier recommendations.

The Shore Pac polymer slurry is used to stabilize the pier hole, and the slurry is used for the maintenance of the stability of the unlined drilled pier hole allowing acceptable concrete placement when water seepage into a drilled pier hole is too severe to permit concreting in the dry.

Samples shall be taken and tested when drilling the rock socket is complete, but prior to final cleaning of the bottom of the shaft. When the slurry sample is in accordance with the requirements the bottom of the shaft shall be cleaned and any loose or settled material removed. The slurry quality and consistency must be maintained during the drilling of the rock socket and not diluted with water. The polymer slurry cools and lubricates the rock auger and facilitates the suspension of the pulverized rock for easier removal and cleaning of the drilled pier hole.

Shore Pac Slurry & Concrete

During construction of the borehole the Shore Pac slurry is used to hold the hole open, and to facilitate the removal of spoils. When tip point (final depth) is reached the bottom of the hole is cleaned and the rebar cage is set. Next concrete is poured through a tremie pipe placed into the hole just off the bottom. As the concrete fills the borehole the lighter Shore Pac slurry weighing 8.4 lb/gal is displaced and pushed up and out of the hole. Any remaining residual Shore Pac slurry clinging to the rebar or the sidewalls of the borehole is chemically destroyed by the alkalinity of the concrete as it fills and rises within the bore hole.

Shore Pac slurry cohesively binds excavated soil solids together, facilitating their removal from the excavation and preventing them from dispersing into the slurry. Shore Pac maximizes spoil loading on augers increasing excavation rates. Shore Pac makes it possible to drill with augers, even in sand and gravel, eliminating the need to use a bucket necessary with mineral slurry and full length casing. This feature can reduce slurry wastage.

Improved Skin Friction

Shore Pac polymer slurry offers many distinct advantages when compared with Bentonite mineral slurry. Some of the more important advantages would include the following.

- Greater skin-friction load carrying capacity for the side-walls of the drilled shaft, thus increasing the total working load capacity of the pier.
- The elimination of the de-sanding operation, as is necessary with Bentonite mineral slurry. Bentonite slurry suspends sand and polymer slurry does not suspend sand.

During the excavation of the shaft under a head of polymer slurry, all the sand drops to the bottom of the shaft as drilling proceeds.

- Provides cleaner, harder top surfaces on concrete at the top (cut-off) of drilled shafts; reduces or eliminates cleaning, chipping and dressing at cold joints.

- Shore Pac polymer slurry is non-toxic and non-hazardous. When ready for disposal, it is chemically with Sodium hypochlorite (bleach) to break-down to environmentally safe and clean water and by-products.

- Shore Pac is considerably cleaner and more manageable than Bentonite. The residual spoil is drier and firmer,

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and can be used for fill.

Shore Pac polymer slurry replaces mineral slurry at ratios ranging between 1 to 50 and 1 to 200 in typical applications. When using salt water as the mix water only a special mineral called Attapulgite can be used, these ratios mean that 20 pounds of Shore Pac can replace 4 tons of mineral slurry.



Shore Pac Slurry Mixing, Testing & Disposal

Introduction

This specification provides direction in the proper use of Shore Pac[®] and its additives while improving standardization, quality and performance in the practice of slurry-displaced deep foundation construction. This document ensures that engineers and engineering geologists can confidently predict the load carrying capacity of the piling being constructed using an approved slurry, and to ensure that an approved slurry is not detrimental to the structural capacity or service life of the piling.

Scope

This specification covers the use of polymer stabilizing support fluids (“slurry”) based on Shore Pac[®], an easy mixing, water-soluble, polymer supplied as a free-flowing granular material. Shore Pac[®] earth-reinforcing fluids or designed for use in the construction of bored piles and diaphragm walls by the slurry-displacement method.

Selection of Polymer Slurry Materials

The principal polymer is Shore Pac[®], manufactured by CETCO Construction Drilling Products. Additives which have been certified by the manufacturer (CETCO) may be used with approval of the engineer and in accordance with the manufacturer’s recommendations. The strict quality control guidelines have been set forth based on Department of Transportation (DOT) requirements for approval of Shore Pac[®] polymer drilling slurry. These have been applied to ensure the use of proven materials and techniques.

Shore Pac[®] Polymer Dosage and Viscosity

1. Pre-treat water with soda ash 6 lb per 1,000 gallons mix water for a pH of 8-10. Pre-treat water with De-Chlor ½ lbs per 1,000 gallons mix water.
2. Add Shore Pac through a Venturi type mixer @ 8.0-10.0 lbs per 1,000 gallons depending on desired viscosity if mixing in surface tank, if mixing directly within excavation sprinkle into stream of water slowly.
3. Take a Marsh Funnel Viscosity reading, viscosity should be 60-75 sec/qt.

Shore Pac[®] dosage and the viscosity of the slurry shall be selected and controlled within ranges which suit the soil and mix water conditions of the work and in accord with the table below.

Formation Type	Shore Pac [™] Dosage or Concentration			Marsh Funnel Viscosity
	lbs/yd ³	lbs/1,000 gals.	kg/ m ³	Sec/qt
Clay & shale	0.7 – 0.8	3.4 - 4.0	0.4 to 0.5	35 - 50
Silt & fine to med. sand	0.8 - 1.0	4.0 - 5.0	0.5 to 0.6	45 - 55
Coarse sand to pea gravel	1.2 - 1.4	6.0 - 7.0	0.7 to 0.8	55 - 65
Gravels to cobbles	1.6 - 2.0	8.0 - 10.0	1.0 to 1.2	65 - 95

Mix Water Supply and Slurry Creation Ability

Sufficient water supply of proper quality for slurry makeup shall always be available to support planned operations and unknown contingencies. Ample slurry deliverability or making volume shall be immediately and continuously available to support planned operations and unexpected events. If the water supply is from a low-



rate or irregular source such as a small well, a small diameter supply line, or tanker truck, a tank for storage of water shall be used to guarantee adequate and uninterrupted slurry making capacity.

Soda ash should be used to adjust the pH and treat out calcium (Ca) and magnesium (Mg) contaminants that are detrimental to polymers. This will adjust the pH of the mix water to between 8 and 10, which is optimum for Shore Pac[®] performance. The ratio of soda ash to water is 6 lbs per 1,000 gallons of water.

The additive De-Chlor[™] is used to treat out chlorine (Cl) if municipal water is used for make up water. Chlorine, present in municipal water, destroys all polymer molecules and decreases its viscosity if chlorine registers greater than 3 ppm. De-Chlor[™] is a cost effective white granular crystal that neutralizes chlorine in municipal water and is environmentally safe. The ratio of De-Chlor[™] to water is 2 lb per 1,000 gallons of mix water.

Slurry Sampling & Testing

During the excavation of each borehole, slurry samples shall be taken from near-bottom and upper portion at least once during the excavation of each element, and not less than once every four hours, except for overnight shutdowns. When operating conditions make it prudent to sample and test more frequently, sampling and testing shall be done in accordance with a schedule recommended by the Manufacturer or the contractor and approved by the Engineer.

Samples shall be collected with a suitable device (double ball bailer) that captures representative samples of sufficient volume (\geq 1.8 liters or 2 quarts) to perform required testing of the slurry. Samples collected as described above shall be tested for Marsh Funnel Viscosity, pH and specific weight. A written record shall be maintained, showing viscosities, pH values, specific weights, dates, times, excavation identifiers, depths or locations from which samples were taken (excavation, supply tank, mix tank) and other pertinent information as and if specified by the Engineer. Testing of specific weight and sand content may be required by the Engineer before placement of reinforcing steel and concrete, if specifications for these parameters are in force for the project.

Testing of the Shore Pac Slurry

1.) Marsh Funnel Viscosity (MFV)

This test requires both a Marsh Funnel and a Viscosity Cup. MFV is reported in seconds per quart. The time in seconds for a quart of slurry to pass through the funnel tip is reported as viscosity in seconds per quart. The MFV is very useful in determining the concentration of polymer molecules, and also its ability to stabilize surrounding soils.

2.) pH (potential hydrogen- ion)

Dipping a piece of litmus paper in the slurry and comparing the color change to a standard chart performs this test. The result of this test is reported in a number from 1 to 14. The range for maximum **Shore Pac** performance is 8-10. This is the level at which polymer molecules can fully hydrate and extend, creating more viscosity. Levels of pH below 6 (acidic) can affect the performance of the **Shore Pac slurry** and should be adjusted by adding soda ash (Na_2CO_3) @ 5 lb per 1000 gallons mix water. In addition the Soda Ash Carbonate ($\text{CO}_3^{=}$) ion present in 8-10 pH solutions is useful in buffering the slurry against Calcium and Magnesium contamination.

3.) Density

This test is performed with a standard mud balance and is reported as specific gravity, pounds per cubic foot lb/ft^3 or pounds per gallon. The lbs per ft^3 of **Shore Pac** slurry should be approximately 64.0. The density may be slightly higher depending on the amount of fine soil particles mixed in the slurry. Shore Pac slurries have the same density as water, specific gravity 1.0 (\pm 0.05). If the density is outside of this range the Shore Pac polymer concentration could be to low. A viscosity test should be taken to check this.



4.) Sand Content

This test is performed with a standard sand content kit, and the results are reported as percent sand. This test is normally performed at the completion of an excavation and just prior to placing concrete. The sample to be tested should be taken from near the bottom of the excavation. When using **Shore Pac** slurries the sand content will rarely test over 1.0% sand. Due to its flocculating ability, it drops the sand very quickly and the slurry remains nearly sand free. When performing the sand content test in the field the addition of hypochlorite (Slurry Buster) solution in place of water to dilute the slurry sample can prevent the accumulation of silt, which creates false sand reading in the test.

Quality Specifications for Slurries Based on Shore Pac®

Shore Pac® CETCO Drilling Products		
PROPERTY	REQUIREMENT	TEST
Density (lb/ft³) - during drilling - just prior to placing concrete	less than or equal to 64* less than or equal to 64*	Mud Weight (Density) API 13 B-1 Section 1
Viscosity (seconds/quart) - during drilling - prior to final cleaning - just prior to placing concrete	35 to 135 less than or equal to 60 less than or equal to 60	Marsh Funnel and Cup API 13 B-1 Section 2.2
pH	8.0 to 10.0	Glass Electrode pH Meter or pH Paper
Sand Content (%percent) - prior to final cleaning -just prior to placing concrete	less than or equal to 1.0% less than or equal to 1.0%	Sand API 13 B-1 Section 5
*When approved by the engineer, slurry may be used in saltwater, and the allowable densities may be increased up to 2 pcf. Slurry temperature shall be at least 4° degrees Celsius (40° degrees Fahrenheit) when tested.		

Mixing in Vessels or Tanks

When Shore Pac® polymer is pre-mixed in vessels it shall be added to water that is being passed through a hose, tube or hopper; across a stationary panel or surface; or stirred or otherwise agitated, in a manner which avoids the formation of lumps and results in a uniform mixture of polymer in the water. The polymer slurry shall be agitated until it develops viscosity adequate to be self-suspending (i.e., particles of partially-dissolved polymer do not settle in the fluid). This normally occurs within 15 to 30 minutes. Polymer shall not be mixed in a vessel without adequate agitation. Agitation may be accomplished by use of motorized stirrers, air injection, (as with blowpipes or fixed perforated piping), or other suitable and effective means. Recirculation by a single pump (without other means of agitation) is usually inadequate and shall not be permitted unless the mix tank is small enough that the pump provides adequate agitation of the entire tank.

Maintenance

The slurry level shall be maintained at least 1.8 meters (six feet) above the water table, or as such higher level that is required to overbalance hydrostatic soil pore pressure and maintain soil stability. If the slurry drops below the specified level, the operation shall be paused and the proper slurry level re-established before proceeding. In some situations the Manufacturer may recommend that the slurry be maintained at less than 1.8 meters above the water table, to reduce rates of fluid loss if soil stability is being maintained.



The point of reference for selection and maintenance of slurry level shall always be the water table (piezometric level). This applies even in situations where casing or other protective sleeve has been placed to a depth at or below the water table. The presence of casing does not remove the requirement to keep the slurry level above the water table. Attempts to excavate or hold open an excavation in saturated or unstable soils with inadequate slurry head pressure; even with casing extended into the water table, can be expected to result in soil collapse below the casing.

Preparation for Concrete Placement

Upon reaching final depth, an initial cleaning of the bottom of the excavation shall be effected with an appropriate tool. If indicated, the slurry column shall be allowed to stand static and undisturbed for a period of time to allow sand to settle toward the bottom of the hole. Slurry samples shall be taken intermittently during this static period from the midpoint of the excavation and from within 60 centimeters of bottom to determine sand content, viscosity, pH and specific weight. When sand content and specific weight of near-bottom and midpoint samples are within specified maximums (see slurry quality specification tables) or when they stabilize and show no further change over a 30-minute interval during which the excavation is completely static and

Tools have not been inserted (indicating sand held in stable suspension), the bottom of the excavation shall be cleaned and placement of rebar and concrete may proceed.

If the sand-size particles in the fluid are not in stable suspension but are settling very slowly, other measures may be required, for example, adjusting the fluid properties to stabilize the suspension and keep the sand from settling; agglomerating soil particles into masses which can be extracted by the excavating tools; exchanging the fluid in the excavation with clean fluid; treating the slurry with additives to accelerate settling; or otherwise enhance removal of suspended soil.

Recycling of the Shore Pac Slurry

After the slurry testing has been completed and the rebar has been placed, a suction line should be dropped just inside the excavation for recycling of the slurry. While the concrete is being tremied it will displace the slurry forcing it upward. A holding tank large enough to hold the volume of slurry contained within the excavation is required to recycle the Shore Pac slurry. When concrete is tremie pumped into the bottom of the hole, the displaced Shore Pac slurry is pumped from the top of the excavation into the holding tank using a centrifugal pump. Disregard concerns about shearing the polymer and destroying it, this is the only pump that will pump a large enough volume to keep-up with the concreted pump truck.

Avoid pumping the last three feet of slurry above the concrete interface, this slurry will be contaminated from contact with the concrete. The impacted slurry looks like oatmeal and only occurs at the contact with the concrete. The last three feet of impacted slurry can be pumped off to a waste tank or allowed to spill over the top can onto the ground to be mixed into the spoil pile by the loader.

The recycled Shore Pac slurry is tested for viscosity and pH. While adding water to restore the original volume additional soda ash is added to adjust the pH. Next the Shore Pac is added to restore the slurry to full strength. Usually it requires about ¼ of the amount of Shore Pac added to the water filling up the holding tank to restore the slurry to its original strength for reuse on the next hole.

Break-Down of Slurry

Shore Pac slurry fluids are non-toxic and are readily degradable upon completion of a slurry job to facilitate disposal. Upon completion of the project, any remaining **Shore Pac** is broken down with the chemical oxidizer (**Slurry Buster**) the most common oxidizer for this purpose. Slurry Buster is Sodium Hypo chlorite solution (household bleach).



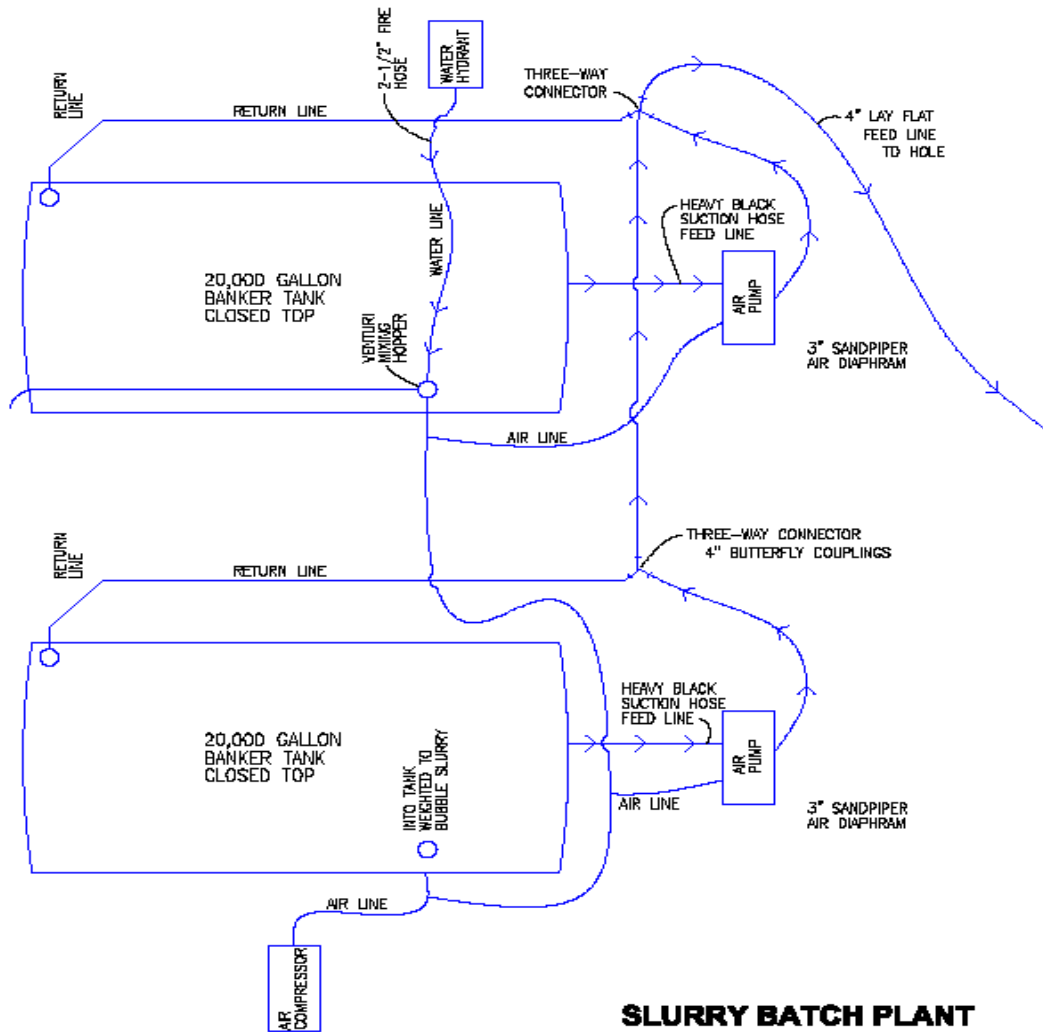
The Slurry Buster solution is added to the Shore Pac slurry at a rate of 3 gallon per (3,000gallons) of slurry to be treated. After the hypochlorite breaker is added, the slurry is circulated using the pumps on-site to ensure complete oxidation of the polymer molecules. This is accomplished by pumping it back into a holding tank or breaking it down right in the hole and agitating with the auger.

The Slurry Buster concentrations of 3-gallons per 3,000 gallons of slurry destroys the active ingredients within the Sodium Hypochlorite and at the same time kills the polymer, reverting it back to basic water. The end result of Shore Pac decomposing after its encounter with (**Slurry Buster**) is the acrylic acid backbone not a toxic substance.

Disposal of Drilling Slurry

Treated slurry fluids are environmentally safe when handled as directed. When breakdown is complete, **all that remains is trace acryl ate molecules and water.** The anionic Shore Pac is reduced to water after the hypochlorite is used to treat the Shore Pac. This is often safely discharged or simply spread on the ground to evaporate or used in dust control.

Additionally, polymers with the same chemical base as found in Shore Pac are used in potable water treatment as flocculants, with federal government clearance. They are widely used throughout the world as coagulants and flocculants used for environmental and process improvement, acting through solid/liquid separation. They are used in paper manufacturing, wastewater treatment, mineral and oil extraction, soil conditioning and as thickeners in cosmetics. As such, they have many regulatory approvals around the world, such as for drinking water treatment, indirect additives for food-contact paper and for other specific uses. Municipal sewage sludge, which has been polymer-treated for de-watering, is widely applied to agricultural land.



SLURRY BATCH PLANT