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 are 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 lb 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 (≥ 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) @ 6 lb per 1,000 gallons mix water. In addition the Soda Ash Carbonate (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 (± 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 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/ft^3) - 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, hopper, across a stationary panel or surface, 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 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.

The Slurry Buster is added to the Shore Pac slurry at a rate of 3-5 gallons per 3,000 gallons Shore Pac slurry (For a fast break) 1-2 gallons per 3,000 gallons Shore Pac (For slow break 24 hours). This is accomplished by

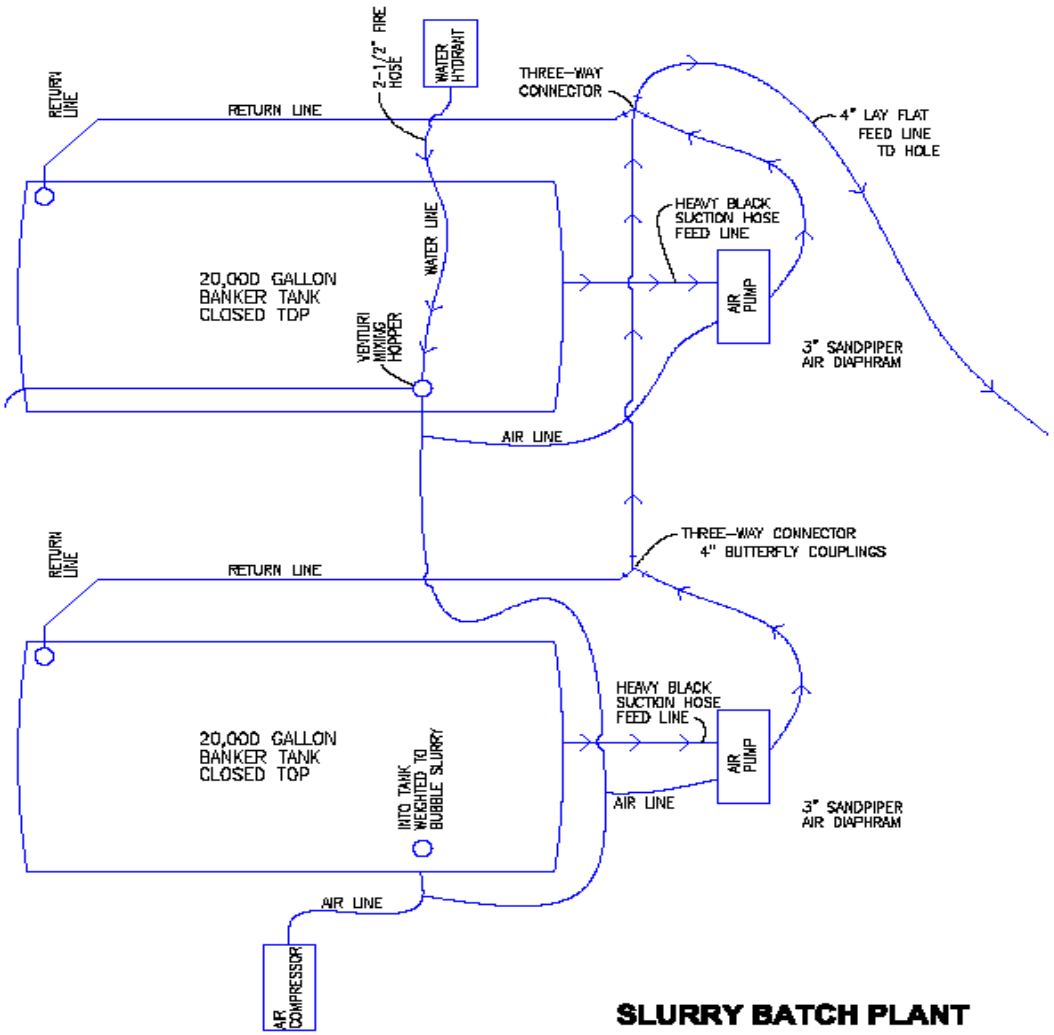
pumping it back into a holding tank or holding pond and circulating it using the pumps on-site to ensure complete oxidation of the polymer molecules.

The Slurry Buster concentrations of 3-5 gallons per 3,000 gallons of Shore Pac 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 a non-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 acrylate 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