Foundation Technologies, Inc.
FAMILY OF BRANDS

MINERALS TECHNOLOGIES CETCO®

USE OF SHORE PAC® POLYMER SLURRY

IN SLURRY-DISPLACED FOUNDATION CONSTRUCTION

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.

ADVANTAGES

The advantages of using high performance polymer slurry over mineral slurry yield multiple benefits, which improve construction economics in many ways. SHORE PAC saves time and money while improving construction quality and reducing defects.

- Controls fluid loss in sands and gravels. Stabilizes excavations
- Highly concentrated. Very small quantities required
- Improves productivity of machines and crews
- Reduces chipping and cleaning of poured concrete
- Reduces or eliminates disposal costs. Product is environmentally safe
- Reduces transport costs and storage space requirements
- Requires less mixing/processing equipment, reducing capital investment, jobsite congestion, and fuel costs

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 fluid is designed for use in the construction of bored piles by the slurry-displacement method.

SELECTION OF POLYMER SLURRY MATERIALS

The principal polymer is SHORE PAC, manufactured by CETCO. 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 set forth by the California Department of Transportation (CALTRANS) requirements for approval of SHORE PAC polymer drilling slurry have been applied to ensure the use of proven materials and techniques.

SHORE PAC POLYMER DOSAGE AND VISCOSITY

SHORE PAC is an easy mixing, water-soluble, polymer supplied as a granular material. SHORE PAC is designed for preparation of viscous earth-reinforcing fluids or slurries for a variety of drilling, trenching, and walling applications in the geo-construction industry.

1. Pre-treat make-up water with SODA ASH 3-6 lbs per 1,000 gallons make-up water for a pH of 8-10. Pre-treat make-up water with DE-CHLOR 0.5 lb per 1,000 gallons mix water.
2. Add SHORE PAC through a Venturi type mixer at 3.5-12.5 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 35-125 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 according to table 3.1. If viscosity ranges are needed above or below the ranges in table 3.1 please consult with a CETCO representative.

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	3.5 - 5.0	0.5 - 0.6	35 - 50
Silt & Fine to Med. Sand	0.8 - 1.0	5.0 - 7.0	0.6 - 0.8	50 - 70
Coarse Sand to Pea Gravel	1.2 - 1.5	7.0 - 9.0	0.8 - 1.0	70 - 90
Gravel to Cobble	1.7 - 2.4	9.0 - 12.5	1.0 - 1.5	90 - 125

MAKE-UP WATER AND EFFICIENT SLURRY PRODUCTION

Sufficient water supply of proper quality for slurry make-up water shall always be available to support planned operations and unknown contingencies. Slurry mixing capability 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. SODA ASH 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 3-6 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 0.5 lb per 1,000 gallons of mix water.

CONTAMINATES

Polymer slurries are sensitive to various contaminants, which occur in groundwater, soil, cement, and make-up water. Petroleum hydrocarbons, calcium, acidity, alkalinity, chlorine, and sodium chloride are some contaminants that will affect the polymer slurry. These contaminants are often introduced into the slurry from the soil, groundwater, and/or industrial wastes at the construction site. There is a need to identify and correct these problems for a smooth operation to take place. This begins with geotechnical engineers in the site investigation process. Identification and documentation should be present with soil logs and passed onto the general contractor and subcontractors. The procurement of samples of groundwater and the analysis of such samples for pH and contaminants should become a standard part of subsoil investigations conducted by geotechnical drilling service firms or by your own investigation. When contamination is present or buffering is required, additives shall be used in accordance with manufacturer's recommendations.

MIXING SHORE PAC

SHORE PAC polymer may be mixed pre-mixed in surface vessels or mixed directly within the excavation. The mix water or the prepared fluid shall be treated with appropriate additives as specified by the manufacturer.

MIXING DIRECTLY IN EXCAVATION

When mixing directly in the excavation it is important to have a steady stream of water that is positioned to provide a point of rapid and wide water flow for introduction of the polymer by sprinkling or sifting. Mixing of fresh polymer shall be completed by sprinkling or sifting the polymer carefully onto a flowing stream of water or fluid from a pressurized source directed into the excavation, such that the flowing fluid catches, wets, and separates the polymer grains so that they disperse and hydrate as individual particles, avoiding the forming of lumps or balls of un-mixed polymer. Dry polymer shall not be added directly onto the fluid in the excavation (as opposed to being added on a flowing stream) because this normally produces lumps or "fisheyes." The additive ACCU-VIS will create instant viscosity with out having to shear.

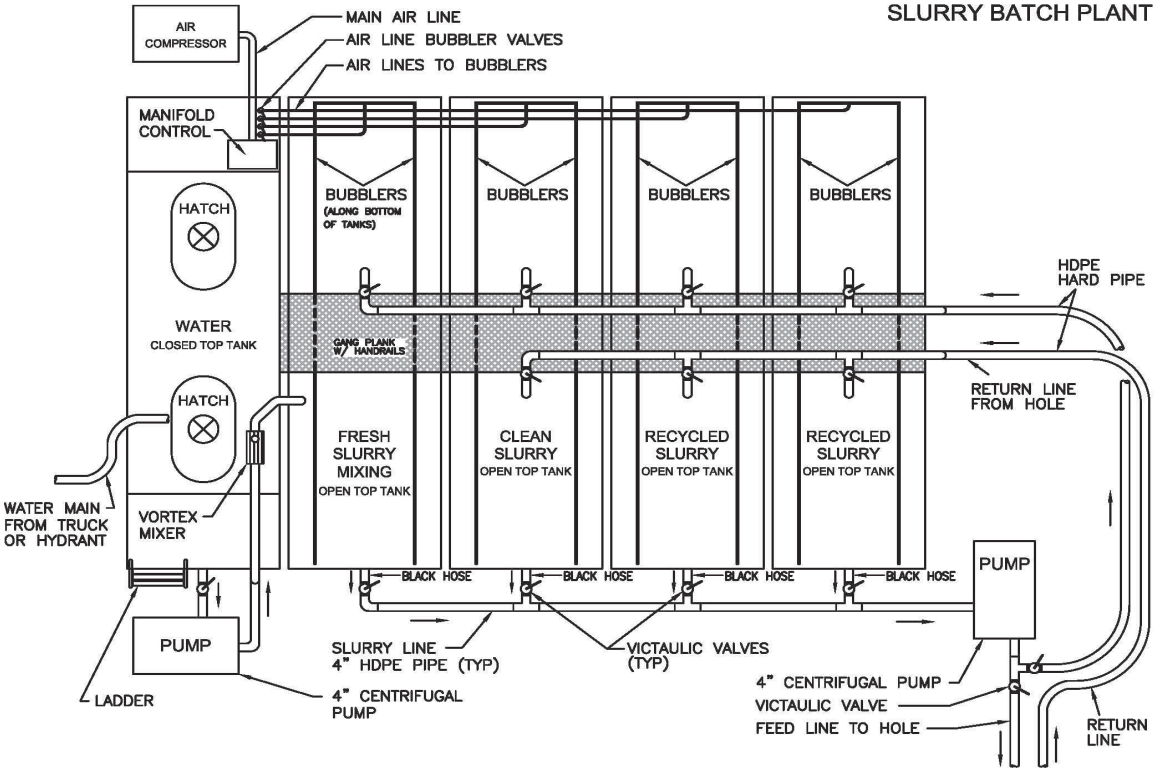
When a new polymer mix is being prepared in a hole that has been dug or drilled to significant depth before adding slurry, the excavation shall be filled with water to a water column height (measured from bottom of excavation) of no less than two meters or 15% of excavation depth, whichever is the greater, before beginning to add the polymer. SHORE PAC dry granular polymer shall be added at a controlled rate on the stream of water that is filling the hole in order to avoid lumps and fisheyes. The excavating tool (auger, bucket, clamshell) shall be reciprocated gently the full length of the slurry column while the polymer is being added, to distribute and even out the fresh polymer, and to ensure that none of the polymer settles to the bottom of the excavation during the mixing and thickening process.

When adding fresh dry polymer to recycled fluid directly in the excavation, special care must be taken to ensure good dispersion of the polymer grains to avoid forming lumps. This is because the polymer wets-out and disperses more slowly in thickened fluid than in plain water. Fanning the recycled fluid across an auger or other object to provide a point of wide and rapid flow facilitates the adding of fresh dry polymer.

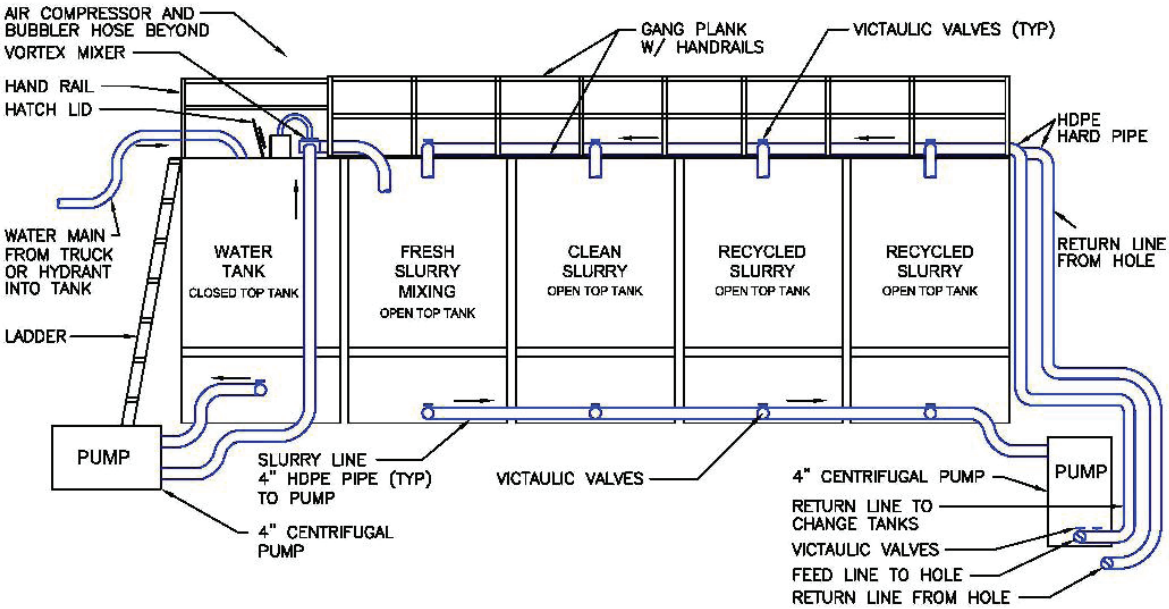
MIXING IN VESSELS OR TANKS

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.

SLURRY BATCH PLANT



SLURRY BATCH PLANT
(FRONT ELEVATION)



ADDITIVES

CETCO has developed a complete line of additives as companion products for SHORE PAC when problem conditions arise. Additives shall be used in accordance with recommendations listed in the table to the right. Control guidelines for use of these additives shall be pH, chlorine levels, contaminant levels, fluid behavior, and other parameters as specified by manufacturer.

This system based on the SHORE PAC polymer and specialized additives, has a track record of delivering the highest levels of performance and project economy of any slurry technology on the market including bentonite.

With this system you can stabilize the most challenging of formation conditions, cohesion-less sands, open corals, cobbles, etc., thereby eliminating collapses and controlling fluid loss. This results in reducing concrete over-breaks, saving on the quantity of concrete consumed, polymer consumed, and the time required for drilling while providing the highest levels of skin friction and rebar bonding available with a slurry system.

MAINTENANCE

The slurry level shall be maintained at least 6 to 10 feet (2 to 3 meters) 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 6 feet (2 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.

SAMPLING AND TESTING

Samples of the slurry shall be taken from near-bottom of the excavation, from the upper portion of the excavation, and from the slurry supply tanks (if applicable) at regular intervals during the excavating process in order to facilitate control of slurry properties.

PRODUCT	RECOMMENDED DOSAGE RATE	DESCRIPTION	FUNCTION
ACCU-VIS	Add 2-3 gals in weighted sealed plastic bag to desired area. Break open with auger and mix with drill tool	Liquid anionic polymer	Stabilizes loose granular soil, instant viscosity, no need to shear with fluid
CETCO CRUMBLES	Add into hole to stop slurry loss	8-20 mesh granular sealant	Controls slurry loss in extreme conditions
DE-CHLOR	0.5-1.0 lbs/1,000 gals mix water	Dry chlorine neutralizer	Treats chlorine in municipal water, increases yield and performance of slurry
INSTA-CLEAR DRY	0.5-1.0 lbs/1,000 gals mix water	Dry chlorine neutralizer	Treats chlorine in municipal water, increases yield and performance of slurry
SLURRY BUSTER DRY	15 lbs of SLURRY BUSTER DRY per 10,000 gallons SHORE PAC polymer slurry	Industrial grade oxidizing agent	Breaks slurry to water
SLURRY SEAL	1-12 lbs SLURRY SEAL per 1,000 gallons SHORE PAC slurry	Specially synthesized polymer nano composite	Fluid Loss Additive
SODA ASH	3-6 lbs/1,000 gals mix water	Dry pH adjuster	Optimizes polymer performance and yield
SODIUM BICARBONATE	5 lbs/1,000 gals mix water	A buffer used to lower pH	Treats slurry impacted by concrete

SAMPLING AND TESTING (CONT'D)

During the excavation of the borehole, slurry samples shall be taken from near-bottom and upper portion at least once during the excavation, 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, and locations from which samples were taken (excavation, supply tank, mix tank) and other pertinent information as 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.

FLUID LOSS

If high rates of fluid loss (seepage of slurry into the soil) are encountered, the polymer dosage and viscosity of the slurry shall be increased as required to provide adequate control of fluid loss consistent with allowed ranges of slurry viscosity. Alternatively or additionally, fluid loss control agents or other treatments recommended by the manufacturer may be used. Use only additives that are certified by the manufacturer to be compatible with the slurry in use.

FLUID LOSS ADDITIVE

CETCO CRUMBLES is a specially blended mineral used for fluid loss control especially in sandy soils. CETCO CRUMBLES added to SHORE PAC reduces slurry seepage into saturated open sands and gravels. A granular solid, CETCO CRUMBLES, is highly recommended as an additive to SHORE PAC when drilling in loose saturated sands. When cobble or gravel is encountered, the viscosity may need to be increased to help prevent loss of fluid to these possible theft zones.

If losses are severe, it may be necessary to add ACCU-VIS to the slurry to either rapidly gain viscosity or use it as a "Bomb" to cut losses. ACCU-VIS can boost cohesion of sand, gravel, and cobble to stabilize and control slurry loss to a degree. ACCU-VIS sharply reduces slurry loss rates in very coarse soils and reduces bottom hole cleaning time. ACCU-VIS's thick gelatinous texture combines with fines to assist in plugging up the theft zones and helps to hold back heaving sand. The application for ACCU-VIS is 1 gallon per 1,000 gallons of fluid. It can be dropped down in weighted, thin, plastic bags, which can be torn up and mixed by the drilling tool.

ACCU-VIS may also be poured into the top of the hole, as it will mix and become viscous without having to shear by force of fluid. ACCU-VIS can be mixed and distributed through the shaft with the drilling tool without forming fisheyes.

SPECIFIC WEIGHT OF THE SLURRY

Because the primary polymers of the standard SHORE PAC system add no significant weight to slurry, measurement of slurry specific weight is a direct indicator of the soil solids content (sand, silt, clay) of the slurry. Sand content is dealt with by a sand specification. Sand tends to settle to the bottom of the excavation because the SHORE PAC polymer slurry has no tendency to gel, so temporary or transient elevated sand content is not a problem during the excavation process. Aside from sand present in the slurry, the remainder of the slurry's specific weight above the specific weight of water (1.00 kilogram per liter, 62.4 lbs/ft^3, or 8.34 lbs/gal) comes from soil fines dispersed in the slurry. Consequently, the slurry specific weight specification is in effect a limiting factor on the amount of fines that are acceptable in the slurry. High fines content can cause problems if the fines are not held in stable suspension. The slowly-settling fines can create a bed of sediment on the bottom of the excavation after a period of time. The maximum allowable final specific weight for synthetic polymer slurries, according to the present specification, is listed in the specification table.

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 2 feet (60 cm) 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 if 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.

ELAPSED TIME BETWEEN BOTTOM-CLEANING AND PLACEMENT OF CONCRETE

Not more than 120 minutes shall elapse between the final cleaning of the bottom of the excavation and the initiation of concrete placement, unless an exception is approved by the Engineer.

TESTING OF SHORE PAC POLYMER SLURRY

MARSH FUNNEL VISCOSITY (MFV)

EQUIPMENT

1. Marsh Funnel
2. Graduated one quart viscosity cup
3. Stopwatch

PROCEDURE

1. Use a double ball bailer to retrieve approximately 2 quarts of slurry.
2. Check the Marsh Funnel to verify that there is no obstruction in the outlet at the bottom of the funnel and the slurry will have an unobstructed flow. Hold funnel upright with a finger over the outlet. Pour the test sample through the screen in the top of the funnel until the mud level just reaches the under side of the screen.
3. Hold the funnel over the viscosity cup and release finger from the outlet and start timing. Record the amount of time in seconds it takes to fill up one quart.
4. Record time in sec/quart on slurry test report.

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. MFV is very useful in determining the concentration of polymer molecules, and also its ability to stabilize surrounding soils.

pH (POTENTIAL HYDROGEN- ION)

EQUIPMENT

1. pH Indicator Paper

PROCEDURE

1. Dip a piece of pH indicator paper into the slurry and compare the color change to a standard chart. The result of this test is reported in a number from 1 to 14.
2. Record pH on slurry test report.

In this test, 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, 3-6 lbs per 1,000 gallons mix water. In addition, the sodium carbonate ion present in 8-10 pH solutions is useful in buffering the slurry against calcium and magnesium contamination.

TESTING OF SHORE PAC POLYMER SLURRY (CONT'D)

SAND CONTENT DETERMINATION

EQUIPMENT

1. 200-mesh sieve
2. Funnel to fit into sieve
3. Glass sand content tube
4. Wash bottle

PROCEDURE

1. Fill the sand content tube with slurry to the first line marked "mud to here" then fill the remaining space in the tube to the next line marked "water to here". Place your thumb over opening and shake vigorously, inverting several times.
2. Pour the mixture on to the clean, wet screen. Discard the liquid passing through the screen. Add more water to the tube, shake, and pour onto the screen again. Repeat this until tube rinses clean. Wash the sand on the screen until discard water is clear, this removes any remaining silt and clay.
3. Fit the funnel upside down over the top of the screen. Slowly invert the assembly and insert the tip of the funnel into the glass sand content tube. Wash the sand into the tube by spraying a fine stream with the wash bottle making sure not overflow the tube (tapping the sides of the screen may facilitate this process).
4. Allow the sand to settle, from the gradations on the tube, read the volume percent of the sand and record it on the slurry test report.

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 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.

SPECIFIC WEIGHT (DENSITY)

EQUIPMENT

1. Mud balance with base and cap per API spec 13B-1, Sec 1

PROCEDURE

1. Place mud balance on a flat level surface and make sure it is clean of any caked on debris.
2. Fill the cup with the slurry to be tested and place the lid on the cup, seat it firmly but slowly with a twisting motion. Be sure some mud runs out of the hole in the cap to free any trapped air.
3. With the hole in the cap covered with one finger, wash and wipe all of the slurry from the outside of the cup and arm of the balance.
4. Set the arm on the fulcrum base and move the sliding weight along the graduated arm until the cup and arm are balanced.
5. Read the density of the mud at the left edge of the sliding weight.
6. Report the results on the slurry test report to the nearest scale division in lb/gal, lb/ft^3, S.G., or psi/1,000 ft of depth.
7. Wash the mud from the cup immediately after each use. It is absolutely essential that all parts of the mud balance be kept clean for accurate results to be obtained.

This test is performed with a standard mud balance and is reported as specific gravity, pounds per cubic foot or pounds per gallon. The lbs density of SHORE PAC slurry should be approximately 64.0 lbs/ft^3. 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).

DRILLING CONTRACTOR: _____

SLURRY ENGINEER: _____

CONTRACT #: _____

DATE: _____

PROJECT INSPECTOR: _____

SHAFT #: _____

DIAMETER: _____

T.D. DEPTH: _____

HOLE VOLUME: _____

PRODUCTS ADDED: _____

TESTS PERFORMED	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4
Time				
Depth (Feet)				
pH (1-14)				
Marsh Funnel Viscosity (Sec/qt)				
Density (lb/gal)				
Sand Content (%)				
Soil Conditions				

COMMENTS: _____

CETCO REPRESENTATIVE/SLURRY ENGINEER: _____

QUALITY SPECIFICATIONS FOR SLURRIES BASED ON SHORE PAC

SHORE PAC POLYMER SLURRY		
Property	Requirement	Test
Density (lb/ft^3) - just prior to placing concrete	less than or equal to 64*	Mud Weight (Density) API 13 B-1 Section 5
Viscosity (seconds/quart)	35 to 125	Marsh Funnel and Cup API 13 B-1 Section 7.2
pH	8.0 to 10.0	Glass Electrode pH Meter or pH Paper
Sand Content (%) - just prior to placing concrete	less than or equal to 1.0%	Sand API 13 B-1 Section 10
*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°C (40°F) when tested.		

SHORE PAC is not a hazardous waste, nor does it pose any threat to waters when disposed of according to manufacturer's guidelines.

SHORE PAC is approved for use by The Federal Highway Administration, (FHWA) and is used in State Departments of Transportation throughout the nation. The method for disposing the drilling slurry SHORE PAC on Drilled Shaft Projects has been listed within this correspondence.

DEFINITION AND INGREDIENTS OF SHORE PAC

SHORE PAC is a dry granular synthetic anionic polyacrylamide. SHORE PAC is manufactured from co-polymerization of acrylimide and acrylic acid or its inorganic salts. The molecular weight (in the region of several million Daltons) and negative charge density varies (by variation of the ratio of acrylimide and acrylic acid monomer units).

The polymer used in the product SHORE PAC is designated as non hazardous and is water soluble or water dispersible. The term polymer simply means – many parts, or is an organic chemical having a molecular weight above 200, with greater than eight repeating units. Polymers vary greatly in function and basic properties, such as stability, charge, and molecular weight. In general, polymers can be classified as natural, modified-natural, or synthetic. The term "monomer" simply means – a large molecule made up of simple repeating units.

A polymer is a compound that consists of a chain of repeating base units, called monomers. SHORE PAC is a synthetic polymer.

DEFINITION AND INGREDIENTS OF SHORE PAC

SHORE PAC is a very high molecular weight synthetic polymer with negative charges on the backbone. Its high molecular weight gives viscosity to water at low concentrations.

When SHORE PAC is dissolved in aqueous solution, the very long polymer chains dissolve and orient randomly in the fluid in coils. In freshwater, the repulsion of the negative charges on the backbone of the polymer chains causes the coils to expand and to occupy a large volume in the fluid. When the fluid is sheared, the expanded polymer chains are located in different fluid layers in the shear field. The uncoiling of these expanded polymer chains dissipates mechanical energy and results in viscosity.

The high molecular weight polymer chains are so long that different parts of individual polymer chains bridge different solid particles. It is this adsorption on surfaces and bridging of solid surfaces that makes this polymer effective in keeping solids consolidated while drilling a foundation. In addition, the adsorbed layer of hydrophilic polymer on rock surfaces slows down the diffusion of water into the rock.

CONTROL PRESSURE AND STABILIZE THE BOREHOLE

Two types of pressure are exerted on the borehole during drilling, formation pressure and hydrostatic pressure. Formation pressure can collapse the borehole if it is not overcome by hydrostatic pressure pushing back against the formation. Hydrostatic pressure is the weight or density of the volume of drilling slurry pushing against the formation. In order to have hydrostatic pressure, the drilling slurry must push back against the formation with minimal penetration into the formation. In unconsolidated permeable formations, the hydrostatic pressure occurs when the weight of the fluid is in contact with the impermeable deposits (filter cake) placed on the sides of the borehole by the drilling slurry. The filter cake and the hydrostatic pressure thereby control the formation pressure, reduce slurry loss and prevent caving, resulting in hole stabilization.

QUALITY SPECIFICATIONS FOR SLURRIES BASED ON SHORE PAC

Normal water weighs 8.34 lb/gal, with the SHORE PAC polymer fluid at 8.40 lb/gal it is necessary to maintain the slurry level 6 to 10 feet (2 to 3 meters) above the surrounding groundwater level. Under normal conditions this hydrostatic pressure, or head, exerts the pressure necessary (approx. 450 to 640 lb/ft^2, or 2,000 to 3,000 kg/m^2), to support the walls of the excavation and is required to ensure hole stability. Without this positive pressure exerted by the slurry column against the sidewall, soil overburden pressures will cause the excavation to collapse. The natural soil overburden pressures forced against the positive pressure exerted by the slurry column result in little or no leach ability to the surrounding formation.

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, as 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 should be pumped off to a waste tank, or if allowed the cement contaminated slurry can be released 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.

BREAKDOWN OF SLURRY

SHORE PAC slurry fluids are non-toxic and are readily degradable upon completion of a project to facilitate disposal. Upon completion of the project, any remaining SHORE PAC is broken down with the chemical oxidizers. SLURRY BUSTER DRY is the most common oxidizer for this purpose. SLURRY BUSTER DRY is calcium hypochlorite.

SLURRY BUSTER DRY is added to the SHORE PAC slurry at a rate of 15 lbs per 10,000 gallons of SHORE PAC slurry. 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.

SLURRY BUSTER DRY concentrations of 15 lbs per 10,000 gallons of SHORE PAC destroys the active ingredients within the sodium hypochlorite (bleach) 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 DRY is the acrylic acid backbone which is an inert nontoxic 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, water and perhaps some small amount of excess chlorine. The anionic SHORE PAC is reduced to water after the hypochlorite is used to treat the SHORE PAC. This is often safely discharged, or 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.

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