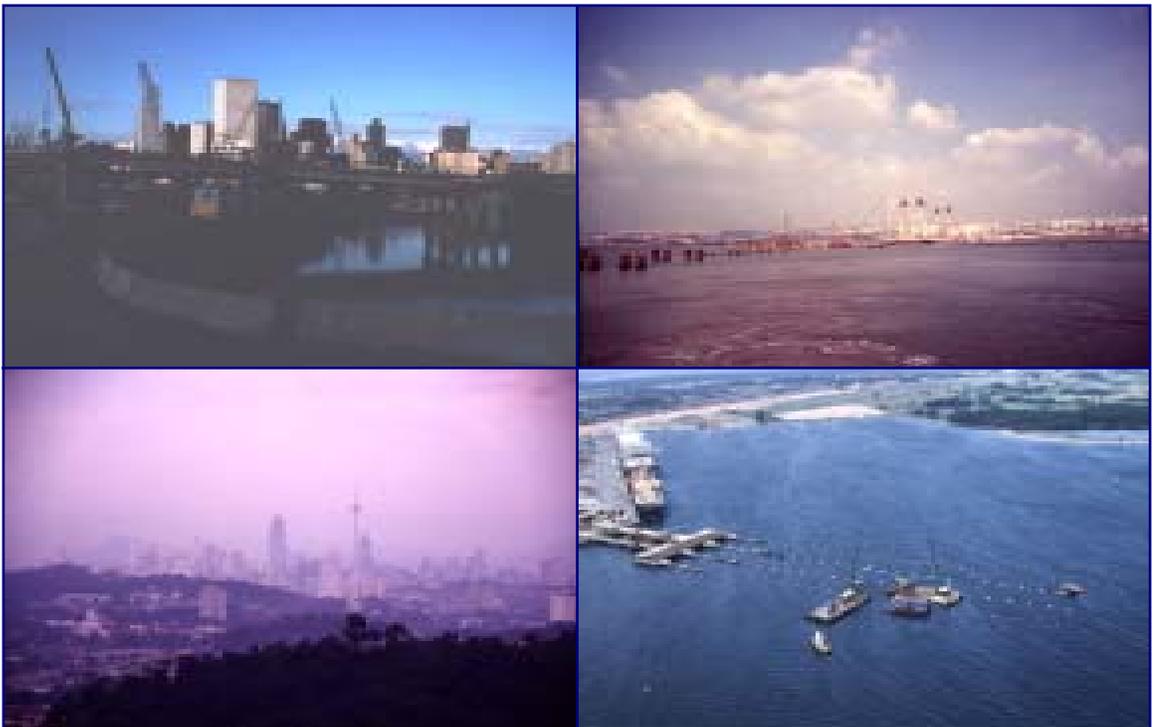


*A Technical Discussion*

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# The SlurryPro<sup>®</sup> CDP<sup>™</sup> Synthetic System



**Technology to Build On<sup>™</sup>**

# The SlurryPro® CDP™ System

## Description and Function

SlurryPro CDP is a water-soluble vinyl polymer in an innovative easy-mixing dry granular form. SlurryPro CDP is designed for preparation of viscous earth-stabilizing fluids or slurries for a variety of excavation techniques including drilling, trenching and walling applications in the geoconstruction industry.

## Application

SlurryPro CDP polymer is recommended for the following construction applications:

- Drilled Shafts/Bored Piles
- Diaphragm Walls
- Tieback Anchors
- Tunneling/Horizontal Drilling
- Slurry Trenching

## Performance

High-performance products yield multiple benefits which improve construction economics in many ways. SlurryPro CDP's high performance saves time and money while improving construction quality and reducing defects.



Above: Hydrocutter operating on the Boston Central Artery Project along active rail tracks at North Station.

- Highly concentrated. Very small quantities required.
- Controls fluid loss in sands and gravels. Stabilizes excavations.
- Reduces chipping and cleaning of poured concrete.
- Improves productivity of machines and crews.
- Requires less mixing/processing equipment, reducing capital investment, job site congestion and fuel costs.
- Unlimited storage life (other polymers can degrade in storage before they are used).
- Reduces or eliminates disposal costs. Product is environmentally safe.
- Reduces transport costs and storage space requirements.

SlurryPro CDP polymer replaces bentonite at ratios ranging between 1-to-50 and 1-to-200 in typical applications. This means that 20 pounds (10 kg) of SlurryPro CDP can replace one-half to two tons (500 to 2000 kilos) of bentonite.

SlurryPro CDP mixes readily with water and requires no special mixing equipment. Small quantities of SlurryPro CDP can rapidly create a viscous soil-stabilizing slurry.

SlurryPro CDP stabilizes loose sands, clays, and water-sensitive formations. SlurryPro CDP fluids cohesively bind excavated soil solids together, facilitating their removal from the excavation and preventing them from dispersing into the slurry. SlurryPro CDP maximizes spoil loading on augers and in grabs, increasing excavation rates. SlurryPro CDP makes it



possible to slurry-drill with augers, even in sand and gravel, often eliminating the need to use a bucket. This feature can reduce drilling time, increase productivity and reduce slurry wastage.

SlurryPro CDP slurries are non-gelling, even at high viscosities. This property facilitates settling of fines and maintenance of a clean fluid. Sand settles readily to the bottom of the excavation and can be easily removed. Mechanical desanding is not required. Unlike bentonite slurries, which tend to suspend sand and require



## Performance, continued:

mechanical desanding, SlurryPro CDP slurries are self-cleaning by gravity sedimentation. The addition of dilute SlurryPro MPA™ or ImPac™ to a SlurryPro CDP system enhances the agglomeration, or gluing together, of dispersed particles for accelerated sedimentation. This facilitates cleaning of the fluid and of the excavation toe.

SlurryPro CDP, and most of the Vinyl System's additives, can be mixed directly in the borehole or excavation when desired. This can be helpful in successfully excavating through problematic granular soils such as loose sand, gravel, cobbles and other unstable formations. SlurryPro CDP is highly efficient, requiring small quantities of product to prepare large volumes of slurry. Operating efficiency of SlurryPro CDP can exceed by a factor of five the performance of competitive liquid polymers.

In addition to providing superior viscosity development, SlurryPro CDP polymer's membrane development and adhesion characteristic improve loading and removal of spoil, stabilize excavation walls and



**Above:** SlurryPro CDP being added directly to a bored pile in Bangkok.

improve skin friction in bored piles. Diaphragm wall panels are smoother and require less finishing work.

Because SlurryPro CDP is highly concentrated, its higher level of performance provides greater economy and simplified storage and handling.

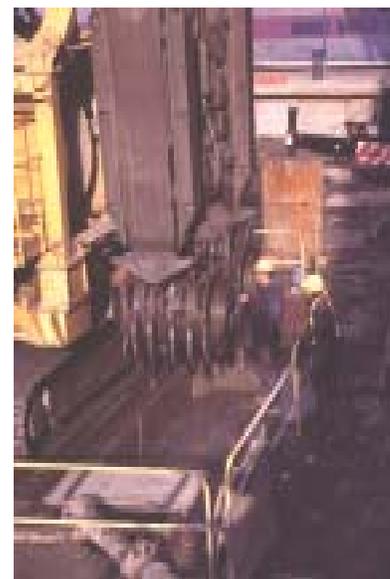
SlurryPro CDP also provides excellent control of fluid loss to permeable sands and granular formations by plugging and sealing pore spaces and voids with a Gel Membrane™ seal formed by the polymer within the walls of the excavation. This is a unique and valuable feature of SlurryPro CDP, which can dramatically reduce slurry consumption and operating/production costs while improving soil stability. Gravel and cobbles can be handled by adding KobbleBlok™ to the SlurryPro CDP system.

Formations as challenging as clean cobbles in the Pacific Northwest of the United States to highly channelled corals in Miami Florida are able to be successfully excavated through with true fluid loss control as seen at the top of the next column.

SlurryPro CDP lubricates excavating tools, reducing friction and wear. This allows increased operations time even with hydro-cutter.

## Proven Performance Advantages

SlurryPro CDP polymer system's have been shown, in definitive laboratory research and in numerous full-scale load tests and construction projects, to provide the following advantages over bentonite slurries:



- Greater frictional load bearing capacity (skin friction) in bored piles; higher success rate on load tests.
- Significantly increased concrete to rebar bonding capacities.
- Cleaner, harder top surfaces on concrete in bored piles and

# The SlurryPro® CDP™ System

diaphragm walls; virtually eliminates cleaning, chipping and dressing.

- Cleaner, smoother exposed diaphragm wall surfaces.
- Tighter joints between wall panels; improved water tightness.
- Increased tension loading achieved in tieback anchors.
- Sea water tolerant.
- Improved recyclability and re-usability.
- Cleaner, more manageable sites.
- Drier, cleaner, firmer spoil which can be used for fill.
- Simplified disposal.

When all of the SlurryPro System's advantages are taken into consideration and their economic impact is understood, it becomes clear that SlurryPro CDP is the technology that will replace both mineral and conventional polymer slurries because neither slurry technology cannot remain competitive. Numerous foundation contractors, including some of the largest and most respected companies in the international industry, have adopted this new technology after trying it on critical, high-profile jobs where efficient performance was required to meet schedules and make a profit. In some cases, the CDP Vinyl System has been tried only after repeated load test failures in problem soils with bentonite or conventional polymer systems, and in every case the CDP Vinyl System has shown much better results. Removing uncertainty on excavation stability, concrete overbreaks, load tests and keeping projects on schedule translates into large monetary savings and reduced liability.

## SlurryPro's Impact on Concrete Interfaces.

One of the most visual benefits of the SlurryPro CDP Vinyl System is its dramatic improvement in concrete interfaces and reduced concrete overbreak rates. The reduction in concrete overbreak rates is due in part to the clean, uncontaminated concrete interface eliminating the need to over pour excavations with several cubics of concrete to insure the absence of bentonite contamination. The improvement is also due in part to improved excavation stability which yields more gauge excavations. These factors combine to yield significant reductions in concrete consumption and thereby concrete expenditures.

The following photographs clearly illustrate the improvement in concrete interfaces when utilizing the CDP Vinyl System.

More importantly than the reduction in concrete consumption, or cost, is the very significant reduction in preparation costs for the connection of the foundation system to the superstructure. **The reduction in chipping or surface preparation of the foundation element may yield projects savings that more than compensate for the cost of the entire slurry system.**

## The CDP System's Impact on Equipment Requirements is Remarkable

The equipment requirements for SlurryPro CDP Vinyl System are far simpler than those required for mineral slurries (e.g. bentonite) to the extent that vibrating screens

and cyclonic desanders are not required. Mixing apparatus is also simpler than for bentonite, because of the ease with which CDP polymer can be mixed into flowing water



**Top:** A typical bentonite diaphragm wall covered with contaminated Bentonite / Concrete.

**Center:** A panel completed with the CDP Vinyl System on the same project just a few panels away.

**Below:** A 12 ft. diameter pile dug in water sensitive clay with the Vinyl System.



## Impact on Equipment Continued:

without forming lumps. A sloping pan over which a water flow is directed into a standard tank takes the place of a bentonite mixer. Typical recirculating bentonite mixers, which can prepare one or two cubic meters or yards of slurry at a time, can require many hours to prepare significant volumes of slurry, which must be aged to achieve full hydration. By contrast, a simple 6 cubic meter agitated tank can be used to prepare 20 to 60 cubic meters or yards of SlurryPro CDP slurry in a matter of minutes, and the slurry can be used immediately.

One or two sedimentation tanks or pits take the place of mechanical desanding plants. Holding the fluid recaptured from a hole or panel for a short period of time in sedimentation tanks allows the CDP fluid, which is non-gelling, to be cleaned by gravity. Any sand and silt which did not settle in the excavation will instantaneously settle in the sedimentation tanks and can be cleaned out intermittently.

The photographs of a bentonite plant operating a hydrocutter, or hydrocutter in water dispersible formations compared with a SlurryPro CDP System plan operating under the same parameters at flow rates of up to 1500 gal/min. clearly demonstrate numerous advantages associated with the SlurryPro CDP System.

The SlurryPro CDP Vinyl System has been utilized continuously for the past six years on the Boston Central Artery Project on both hydrocutter, hydraulic grab, and conventional mechanical grab walls.

KB's System in Boston



Competitive Bentonite System



Mobility and simplicity speak for themselves!

It has been utilized on major sections of the Artery Project ranging from the far northern Leverett Circle / North Station area to the Callahan Tunnel . State Street area to the Southern Fort Point Channel site. The System has also been utilized on significant expansions of Boston's Mass Transit System or MBTA System including the construction of the new Super Station facility next to North Station.

The SlurryPro CDP System has also been utilized to construct significant portions of the Taipei MRT, Singapore MRT, and Bangkok MRT. Additionally, many of the worlds largest structures rest on walls constructed with KB's CDP Vinyl System. Many of these walls have been quite deep and in adverse conditions. The photograph below is of a deep wall constructed in Keoshung Taiwan in sands, cobble and sea water conditions. Note that this is the bottom section of the cage, or half the total depth of the excavation.



# The SlurryPro® CDP™ System

## The Importance of Dosage on Excavation Stability

SlurryPro CDP polymer is mixed with water at dosage rates ranging from 0.3 to 1.5 kilo per cubic meter (2.5 to 8.3 pounds per 1000 gallons, or 0.5 to 1.7 pounds per cubic yard) for most applications. Higher dosage rates are used to stabilize loose or coarse granular soils or to excavate in sea water environments.

Data from field tests and laboratory research show that higher CDP doses and viscosities yield higher perimeter load shear or skin friction values than do lower doses and viscosities. In general, Marsh Funnel Viscosities of 55 or greater are desirable for best soil stabilization and highest perimeter load shear. Lower viscosities (30 to about 45), while functionally effective in some soils, generally provide lower levels of overall performance and operating economy.

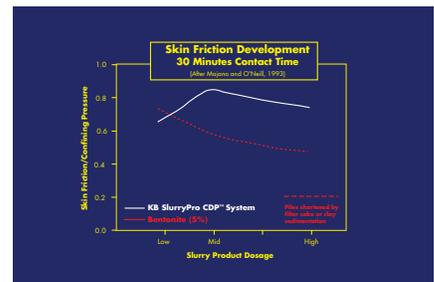
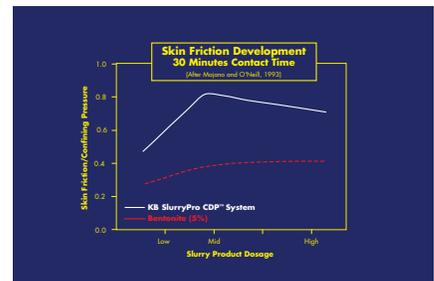
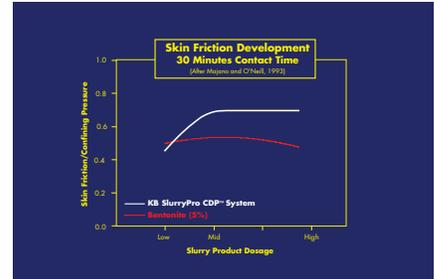
The CDP Slurry System adds cohesion, or a chemical grouting effect, to low cohesion porous soils. This chemical grouting effect dramatically improves the formations strength and stability. This allows the CDP Vinyl System to be utilized in soil conditions previously thought too challenging for slurry technology and requiring temporary casing. An extreme example of the chemical grouting effect of KB's CDP System is presented below where a sugar sand formation excavated with conventional polymer has collapsed. The surface casing was extracted, the pile backfilled



with the excavated spoils and then redrilled the same day with KB's CDP System and an auger.

## The Importance of Dosage on Skin Friction

The superior perimeter load shear and excavation stabilization qualities of the SlurryPro CDP Vinyl System were clearly documented in a three year study conducted by Dr. Mike O'Neill and Dr. Edmundo Majano at the University of Houston.

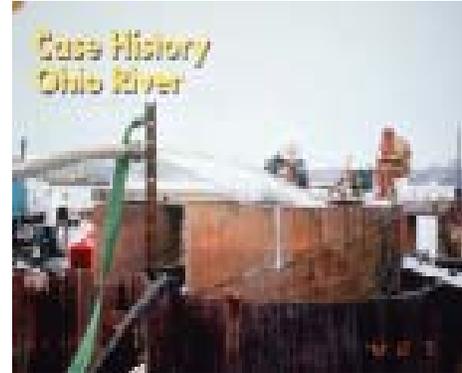


**Above:** Three model bored piles from the U of Houston Study poured after 24 hrs. of excavation open time show perfect geometry.

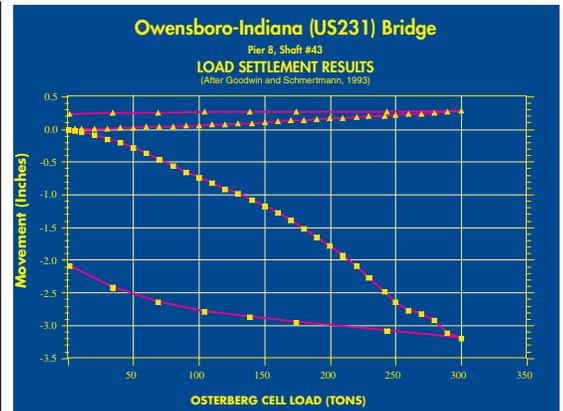
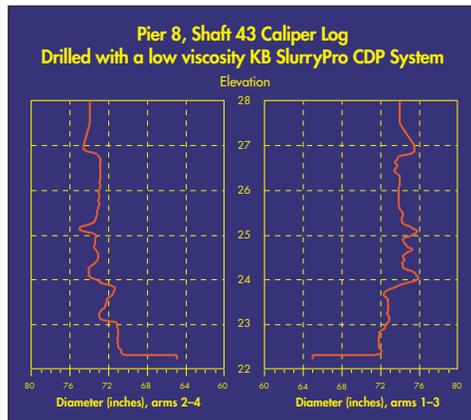
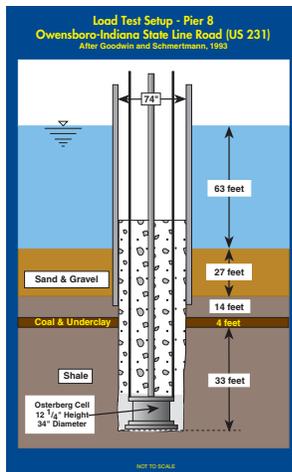
## A Real World Look at the Importance of Dosage on Skin Friction

The four large graphs on the adjacent page show results from load tests and borehole calipers for two bored piles constructed on the Ohio River near Owensboro, KY, U.S.A. Both shafts were slurry-drilled with the CDP Vinyl System into a weathered, hydratable clay-bearing shale which was subject to softening on contact

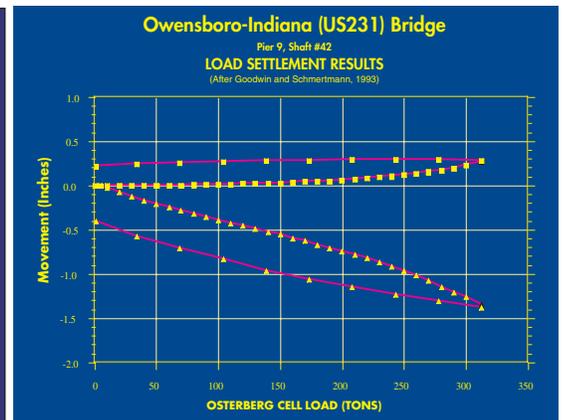
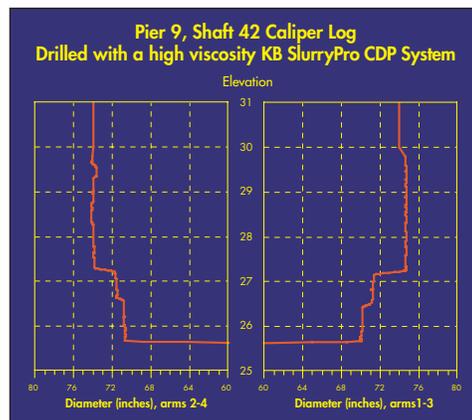
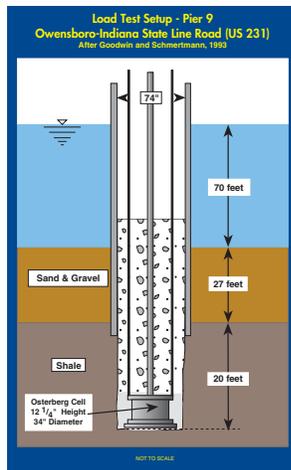
with water or slurry. Shaft 43 at Pier 8 was drilled with a low-dose CDP slurry with viscosity near 40. Shaft 42 at Pier 9 was drilled with a higher dose CDP slurry with viscosity near 60, in accord with KB recommendations. The load-settlement curves and caliper logs show that the high-dose CDP slurry produced a more geometrically correct shaft with superior capacity.



### Pile No. 8 Run at an Average Marsh Funnel Viscosity of 40 Seconds



### Pile No. 9 Run at an Average Marsh Funnel Viscosity of 60 Seconds



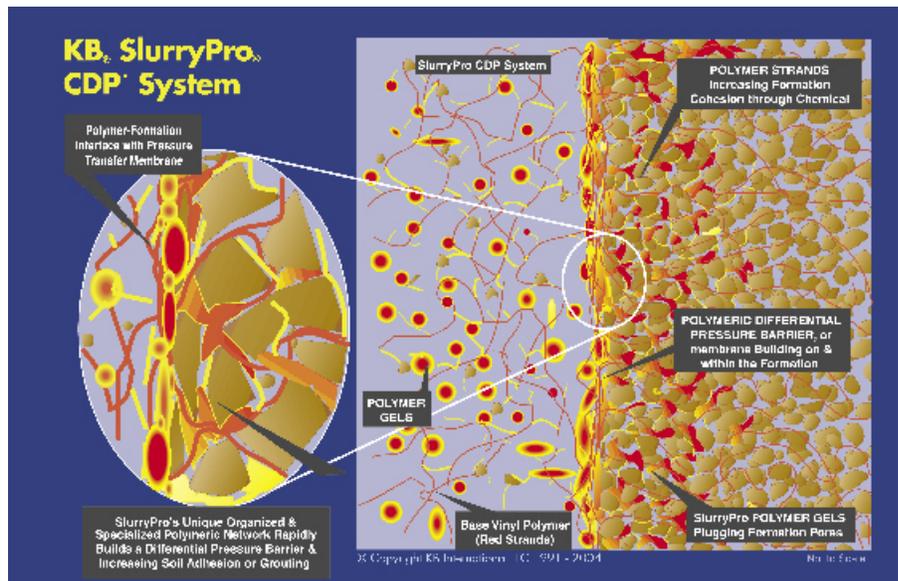
# The SlurryPro® CDP™ System

## How SlurryPro CDP's Vinyl Gel Membrane Technology Works

In permeable soils, especially sand and gravel, SlurryPro CDP penetrates the soil surrounding the excavation with a high-viscosity gel fluid, which becomes immobilized in the pore system of the soil due to the unique chemical and physical properties of the fluid. Millions of small "microgels" and an organized microfilament system lodge in and span across soil pores. This microgel-and-microfilament-reinforced fluid acts to seal the walls of the excavation without depositing a conventional filter cake on the soil face, as is the case with mineral slurries (e.g. bentonite). Due to the electrochemical activity of the polymer fluid, it acts as a soft grouting additive within cohesionless soils, effectively "gluing" the grains of soil together during the excavating process. Thereby, allow even cohesionless soils to be stabilized and excavated under the CDP System.

This relatively thin zone of gel-permeated, cohesion-enhanced soil surrounding the excavation is the Gel Membrane™, or pressure transfer vehicle. Due to this membrane's high fluid loss control characteristics coupled with its grouting

effects allows the CDP membrane to achieve significant levels of positive hydrostatic pressure exerted from the slurry column to the walls of the excavation, insuring support of the surrounding formation. In mineral slurries this function is served by the clay filter cake which is deposited on the face of the excavation. But the clay filter cake can reduce skin friction by interfering with concrete/soil bonding, and has none of the adhesive properties of the SlurryPro CDP Gel Membrane. With other types of polymer slurries, stabilization of granular soils is relatively poor because the polymers have no mechanism of controlling fluid loss (the uncontrolled permeation of the polymer fluid into the soil). A SlurryPro CDP System combines all the benefits of each competitive system while eliminating their negative impacts.



## Double Concrete's Bonding Capacity to Rebar vs. Bentonite!

The rebar bonding performance of the SlurryPro CDP System offers great advantages over conventional bentonite. In independent testing overseen by Caltrans and the FHWA, KB's CDP System has shown virtually double the performance results as bentonite and essentially the same bonding capacity as water soaked rebar.

### Tensile Strength Data

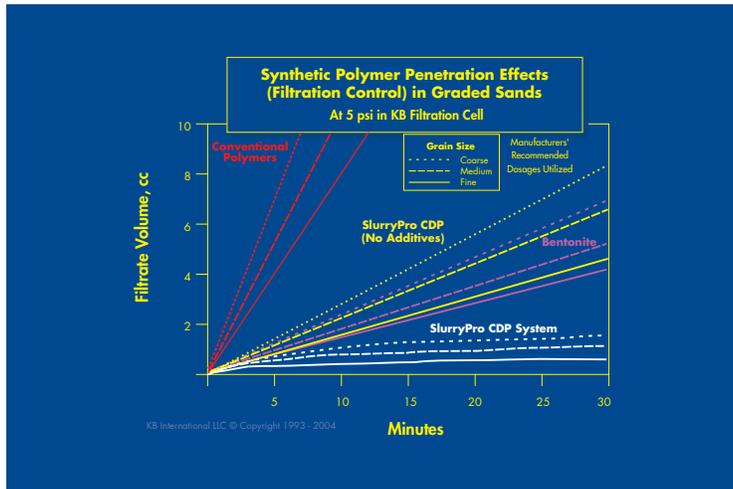
Slurry Product Concentration	Water	Bentonite	PHPA	SlurryPro Vinyl	Water	Bentonite	PHPA	SlurryPro Vinyl	
Marsh Funnel Value	N/A	50.0 g/L	2.86 g/L	1.0 g/L	N/A	50.0 g/L	2.86 g/L	1.0 g/L	
Viscosity sec/qt	26	40	63	70	26	40	63	70	
Tensile Load, Lbs.					Tensile Load, Lbs.				
7 - Days					28 - Days				
1	4,900	1,900	3,180	4,200	4	4,950	2,350	4,020	4,470
2	4,500	2,100	3,460	3,750	5	5,200	2,200	3,560	4,700
3	5,200	2,100	4,260	5,400	6	5,060	2,150	3,420	4,780
Average	4,870	2,030	3,630	4,450	Avg.	5,090	2,230	3,870	4,670

## A Comparison of the Three Major Slurry Technologies

The importance of fluid loss control and the maintenance of positive differential pressure against the formation sidewall can not be stressed enough. Apart from the lack of fluid loss control causing excavation enlargement or collapse as illustrated on page 6, increased fluid loss results in significantly increased consumption of slurry materials. Therefore, it is important to aware of a number of factors prior to choosing a slurry technology solely on its cost per pound or kilo.

## Professional Engineering Service and Support

The SlurryPro CDP Vinyl System is supported by the technological know-how and comprehensive service capability of KB International, the leader in synthetic slurry and earth stabilization technology. KB offers a complete service, starting with analysis of geotechnical borings and continuing through site-specific slurry formulation, cost estimating, equipment selection, slurry plant design, and on-site supervision as required.



### Concrete Mixed with the SlurryPro CDP Vinyl System Demonstrates Increased Concrete Compressive Strengths!

After extensive independent testing under the direction of Caltrans and the FHWA analyzing the impact of SlurryPro CDP System's on the compressive strength vs bentonite and water it is clear that there is no detrimental effects. In fact, the concrete mixed with SlurryPro CDP has a higher integrity then that mixed with water.



#### Compressive Strength Data

Slurry Product	Water	Bentonite	SlurryPro Vinyl	Water	Bentonite	SlurryPro Vinyl
Concentration	N/A	50.0 g/L	1.0 g/L	N/A	50.0 g/L	1.0 g/L
Marsh Funnel Value	26	40	70	26	40	70
Viscosity sec/qt						
	<u>Compressive Strengths, psi</u>			<u>Compressive Strengths, psi</u>		
<u>7 - Days</u>				<u>28 - Days</u>		
1	5,070	5,480	5,360	4	5,720	6,480
2	4,940	5,360	5,380	5	5,860	6,620
3	5,005	5,420	5,420	6	5,790	6,550

# The SlurryPro® CDP™ System

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## Unaffected by Seawater and Other Harsh Environments

Sea water is often present in the ground in coastal or beach areas. Some soils contain layers of gypsum or marl (calcium-bearing deposits which are white, pink or gray in color). All of these soil or ground water conditions can negatively affect the performance of conventional slurries. KB Internationals' SlurryPro CDP Vinyl System is unaffected by seawater. In fact, seawater has been utilized as the make-up water for the CDP Slurry System on several projects including the Richards Bay Port expansion (see opposite page), Leverett Circle and Fort Point Channel on the Boston Central Artery project.



Organic contaminants such as gasoline, diesel oil, hydraulic oil, and other similar hydrocarbon liquids, which are frequently found in the soil on industrial or hazardous-waste sites, normally have no effect on SlurryPro CDP systems. These hydrocarbon liquids are immiscible with CDP, and the small amounts liberated by excavating will normally float to the surface of the fluid in the excavation. Most of the volume of such liquids, if present in the soil being excavated, will remain in the soil due to the hydrostatic overbalance pressure exerted by

the column of CDP slurry in the excavation.

If large quantities of hydrocarbons or solvents are encountered in excavated soil and are carried to the surface plant with the CDP Slurry System, appropriate environmental absorbent materials may be placed on the slurry tank to significantly reduce the quantity of hydrocarbon or solvent present. This practice has been utilized on contaminated soils on the Boston Central Artery.

## Environmentally Friendly

SlurryPro CDP fluids are non-toxic and are readily degradable to facilitate disposal. Because SlurryPro CDP contains no oil, it is environmentally cleaner than liquid emulsion polymers (PHPA, or partially-hydrolyzed polyacrylamides). SlurryPro CDP is high-purity, high-performance Dry Vinyl™ synthetic polymer. In contrast, liquid emulsion PHPA polymers typically contain less than 30% active polymer, up to 35% refined hydrocarbon oil, 3% to 5% surfactants (detergents and emulsifiers), and 30% to 35% water.

In many cases, used SlurryPro CDP fluid can be readily disposed of on-site without treatment. SlurryPro CDP fluids can be further broken down to facilitate disposal or cleanup by treating with Klean-Break™. This "kills" the polymer and reverts the slurry to water. Treated fluids are environmentally safe when handled as directed.

Disposal methods vary from area to area. Although SlurryPro CDP slurries are considered non-hazardous, local, state and federal

regulations must be adhered to with regard to handling and disposal. In many cases the spent slurry can be disposed of on-site or into nearby drains or watercourses with an appropriate permit.

KB and contractors utilizing SlurryPro polymer systems have obtained disposal permits and have disposed of residual CDP-based slurries in a number of locales. These include areas with stringent environmental controls in the U.S.A. such as: Puget Sound (WA); tributaries of the Columbia River (WA, OR); the Salt River (AZ); Boston Harbor (MA); Ohio River (KY, IN); Red River (OK, TX); and several California cities including Long Beach and San Diego. KB has also obtained clearance from the Singapore Department of the Environment for direct discharge to sewers and bodies of water throughout the Republic of Singapore.

The photographs below show a large pier being constructed in Richards Bay South Africa. The specifications for bentonite required that all excavated spoils be captured and hauled to a certified landfill. KB and the contractor petitioned the South African Environmental Authorities for approval for the use of the SlurryPro CDP System to ease environmental impact potential. *In fact, we were successful in*



obtaining certification to directly release all spoils and residual CDP Slurry directly into the bay saving the contractor millions of dollars. Excavated spoils being directly disposed of into Richards Bay



A bridge being constructed over Cedar Creek. A highly protected Salmon spawning tributary to the Columbia River.



Looking down Scenic Cedar Creek.



A close-up of broken down SlurryPro CDP being released to the Creek.



## Alternative Methods for Slurry Disposal

Residual CDP slurry is an excellent and non-toxic dust control agent for construction sites and dirt roads. It can be applied by transferring residual slurry (without chemically breaking it down) to a tank truck fitted with spray bars. The truck then distributes the slurry over the surface of a site or road by spraying. A thin layer of vinyl polymer slurry binds the soil together and dries rapidly, to suppress dust. Using slurry as a dust control agent is a productive and economical way to use a non-toxic waste product to reduce airborne dust pollution.

For more detailed information on mixing, handling and disposing of SlurryPro CDP fluids, please contact your KB International representative or review our technical bulletins on various topics related to the use of the product.

## Human Exposure

A SlurryPro CDP Vinyl System, when run under recommended specifications, has no known adverse effects to humans. Divers have even worked immersed in the Vinyl System for prolonged periods and with multiple exposures over days and weeks for various rea-



sons with not reported or observed adverse reactions, including dermatitis or skin rashes.

Numerous KB employees have been exposed to the SlurryPro Vinyl System on virtually a daily basis for up to seven years with no reported or recognized adverse health impact.

## For More Information...

Additional information on all aspects of the SlurryPro CDP System is available from KB International on request. Standard Operating Procedures provide detailed recommendations for the use of the system in bored piles, diaphragm walls, and other applications. An extensive library of technical information, toxicological and environmental information, case histories and comparative load testing are available on the KB SlurryPro product line.

## Packaging

SlurryPro CDP is available in convenient 10 kilo (22 pound) resealable pails. 25 kilo (55 pound) bags are also available. All additives are available in small resealable pails and in 25 kilo or 55 gallon, 200 liter drums.

## Legal Compliance

Users of our products are responsible for compliance with all government regulations and disposal laws. KB recommends broken down slurry is discharged to local municipalities whenever possible.

The SlurryPro System is covered by the following US Patent's, 5,407,909; 5,663,123; and 6,248,697 and various corresponding International patents. Other U.S. and International patents pending.

# The SlurryPro® CDP™ Earth Stabilization System™

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## The SlurryPro Vinyl System:

SlurryPro® CDP™  
SlurryPro MPA™  
SlurryPro LA-1™  
SandSeal® MMS™  
ProTek® 100

## Advanced SlurryPro Vinyl Additives:

InstaFreeze™  
InstaFreeze C-2  
WeightIt™  
SeaDrill®  
KobbleBlok®  
ImPac™  
KnockOut™

## Introducing KB's Next Generation in Slurry Technology:

**Raising the Standards to New Levels of Simplicity and Quality Assurance!**

**SlurryShield® PBS™**

**SlurryShield® FGP™**

**Please Contact KB International or one of our Agents For Assistance  
when Planning to Utilize our Products!**

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## **For More Information:**

Additional information on all aspects of the SlurryPro CDP Vinyl System is available from KB International LLC on request. General Operating Procedures provide more detailed recommendations for the use of KB's System in bored piles, diaphragm walls, and other applications.

The information in this bulletin is given in good faith and is accurate to the best of our knowledge. Because we can neither anticipate nor control the different conditions under which this information and our products are used, we make no warranty of performance, expressed or implied. Typical properties given herein are not specifications. Our policy is to continually review product formulations and manufacturing to assure technical suitability and cost-effectiveness. Product characteristics are subject to change without notice. Users of our products are responsible for compliance with government regulations and patent laws. The SlurryPro System is covered by the following US Patent's, 5,407,909; 5,663,123; 6,248,697; and 6,897,186 and various corresponding International patents. Other U.S. and International patents pending. All users should discuss the product with an appropriate representative of KB International, LLC before utilizing the product.