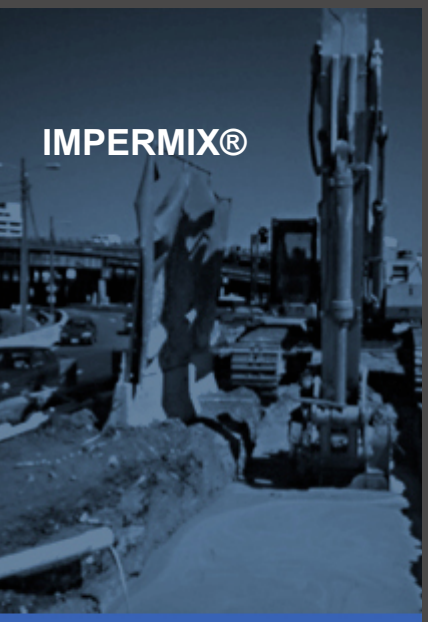

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THE SELF-HARDENING SLURRY STORY

A simple idea that works for patient people. It may even work for less patient people.

For those of you familiar with cement-bentonite slurry (CB), IMPERMIX® is similar but properties are quite different thanks to different types of clay and cement. For those who are only familiar with neat cement grout at water-cement ratios between .4 and 1.5, at a ratio above 1, cement starts settling and the grout is not stable. When we desire stable grouts with water cement ratio of 4 to 10 it is clear that neat cement needs some help to stay afloat: a clay, often a bentonite, acts as a pseudo-plastic viscosifier that produces sufficient gel to maintain cement particles in suspension until the slurry eventually sets. This is cement bentonite slurry that produces a fairly impervious and low strength material.

But if you need

- **Strength**
- **Light weight non-shrink**
- **Very low permeability**
- **Superior chemical resistance**

Then you need IMPERMIX®

Highlights:

• Mixing water can be almost any aqueous medium and to date all contaminants are compatible.

• A E-10 cm/sec range permeability coefficient is possible: 1,000 times better than CB!

• Coefficient of Molecular Diffusion can be 10 to 50 times lower than landfill clay liners and soil bentonite cutoff walls.

• Deep Soil Mixing or Jet Grouting with IMPERMIX® will meet regulatory requirements for containment barriers.

• IMPERMIX® is easy to mix and requires only one mixer as all ingredients go in at once.

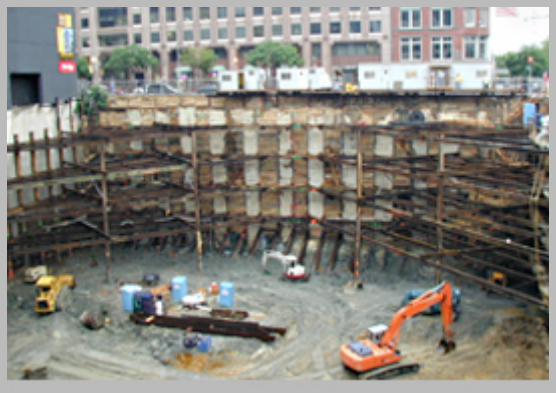
• 50 to 300 psi ultimate unconfined compressive strength, depending on formulation.

Do you know why roman structures are still standing today after more than 2,000 years? Have you seen many concrete structures older than 75 years in good shape? A good thing romans had only pozzolans and lime to work with - Portland cement would wait for the Modern Times to be invented. The cement in IMPERMIX® is a pozzolan not Portland cement. It is actually used to improve Portland concrete.

IMPERMIX® is a very versatile material in geotechnical construction. Applications have developed over the years as part of our continuous service to the construction industry. Invented to overcome the limitations of cement-bentonite in passing performance criteria imposed for containment of hazardous waste by regulatory agencies, IMPERMIX® quickly became an ideal one-phase barrier construction method. As a fluid stable slurry grout, sealing bedding under leaky sewers carrying hazardous liquids and eventually filling sewers to be abandoned became new applications. Other HAZMAT situations have created other avenues.

From an Environmental Protection standpoint, we cannot be GREENER™, IMPERMIX® is actually GREEN!

IMPERMIX® slow set and strength characteristics have led to performing systems for support of excavations which in fact marry traditional shoring systems and self-hardening slurry technology.



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HEAVY CONSTRUCTION

DEEP FOUNDATIONS
Collapsing augered holes and slurry trenched panels have been stabilized by mixing IMPERMIX® in situ using as mixing water whatever fluid is in the opening. The heavy slurry IMPERMIX® slurry has an excellent cake forming characteristic and the settling process assures that upon early cure, re-excavation with a conventional drilling fluid will be uneventful.

When pre-excavation below the water table is required to remove obstacles in the way of some foundation work, a cost effective method is to excavate under IMPERMIX® slurry and let it set in place. Upon curing, the slurry is strong enough to support heavy equipment and presents a cohesiveness helpful to the subsequent penetrations.

SUPPORT OF EXCAVATION

An economical alternative to cast in place concrete diaphragm walls, is to trench the slot under IMPERMIX® slurry and introduce in the wet a prefabricated structural panel, be it laced soldier beams and lagging, mated steel sheet piling or a precast concrete panel. 100% watertightness is provided by the slurry, and linear bearing loads are transmitted by the IMPERMIX® slurry that has at least a 15 tsf capacity when fully cured. Using IMPERMIX® slurry as a drilling fluid for the installation of soldier beam solves the triple issue of drilling mud, bottom socket concrete and shaft backfilling into a single answer: quick and clean.

LIGHT WEIGHT BACKFILLS

IMPERMIX® typical formulations weigh between 68 and 75 pcf. This is much less than soil. When excavation takes place in weak soils, eventually with a subjacent peat or organic silt layer, and if this excavation is below ground water, then the backfilling choice is problematic. IMPERMIX® solves the problem by first permitting the excavation under slurry, second by being light and third by being highly cohesive, any concentrated load on the surface is distributed over the weak layer.

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ENVIRONMENTAL REMEDIATION

Barrier and cutoff walls: originally conceived for a one phase self-hardening slurry cutoff wall construction method, IMPERMIX® because of its intrinsic properties of very low permeability and chemical compatibility with most contaminants quickly served other techniques that can create barriers without trenching like deep soil mixing walls, jet grouted barriers and vibrated beam thin walls.

When hydraulic conductivity reaches as low as E-10 cm/sec and below, a practical limit is achieved in terms of testing laboratory capabilities. The great affinity of slag cement for water causes the cured slurry to continue hydrating while it is permeated. IMPERMIX® exhibits what we call a **threshold hydraulic gradient** below which no flow by advection will occur and the barrier becomes totally impermeable. Molecular diffusion is the only means of chemical transport through the barrier at this point and limit conditions then determine how much chemical may escape the containment. All things being equal, IMPERMIX®'s tortuosity is so complex that the coefficient of molecular diffusion to salt can be 10 to 50 times lower than of a typical clay liner or soil-bentonite slurry wall.

The conventional definition of porosity as per ASTM does not apply to self-hardening slurries, in the same way as it does not apply to sodium silicate gel. You cannot define a wet material's physical properties by destroying it by fire. Cured IMPERMIX® should be seen as a mineral gel of extremely low porosity in its natural condition, hence its very low permeability. Since the actual "pore volume" is unknown, compatibility tests have to be run differently:

a) conventional hydraulic conductivity tests, some time run at gradients of 100 or 200 limit themselves to establish a trend of decreasing permeability under the permeant, after establishing a base line with tap water.

b) IMPERMIX samples are prepared using the worst site water sample as the mixing water. And testing them as per a). This is the proof positive test.

c) An other test, which is akin to a molecular diffusion test, by which a sample base line permeability is measured with tap water as permeant and subsequently immerged in a bath of contaminated water for a period of months. And then retested for hydraulic conductivity again with tap water. Given that sorbtion and molecular diffusion occurs from the outside toward the sample's center, chances are that the porosity has decreased and the permeability has therefore also decreased, if measurable.

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TUNNELING

Rock tunnels may be excavated by machines or by drilling and blasting. Cost is generally the deciding factor except when public relation issues govern as shallow rock tunnels in urban areas. Utility tunnels utilize the bore to install the service conduit, be it sewer or fresh water pipe, steam pipe or power cable duct banks. The remaining space generally needs to be backfilled. Placing a totally liquid backfill that can run thousands of feet and fill in every void, especially after drilling and blasting, has enormous advantages over conventional methods. IMPERMIX® fills this role perfectly as a slow setting, non-shrink grout, low heat, light weight grout. The very low permeability and chemical resistance are the best protection for any buried service. Thousands of feet of tunnels have been backfilled with IMPERMIX® in 2003 in Atlanta for the new municipal drainage system.

Case Study: a 48" valve at the start of a sewer rock tunnel going across the Boston harbor from Nut Island to the Deer Island treatment plant, was to be connected in the future to a land tunnel and had to be protected over a period of 5 to 10 years from the saltwater environment. The solution was to entomb the valve in a chamber (240 feet deep) filled with IMPERMIX®. The 240 CY chamber was backfilled in less than a shift, IMPERMIX® being mixed at the top of the access shaft. Five years later, the chamber was re-excavated by another contractor (same project manager!) using spade jack-hammers as originally contemplated, and the valve was exposed in perfect condition.

Note: The sufficient but reasonable strength of such backfill (150 psi) allows for

easy re-excavation in the future for modernization of this system without having to mine another tunnel.

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TRENCHLESS TECHNOLOGY

Two fields of non-man entry bores are subject to the use of IMPERMIX®. Microtunneling, and other pipe jacking methods, use the jacked pipe as a temporary support and the service pipe is slipped inside once the drive is completed. Large directional drilling bores under river or other natural obstacles may eventually require the bore to be grouted to seal the annulus created between the service pipe(s) and the ground. In long microtunneling drives, the number of options to fill the annulus is reduced.

As in tunnels, flooding the annulus with the fluid IMPERMIX® self-hardening slurry is a very practical solution and cost effective. This operation can even take place after the manholes have been installed and the shafts backfilled by leaving standpipes at both ends. Such technique was used for a number of microtunnels at J.F.K. airport installed by CARP-SECA JV for the N.Y.-N.J. Port Authority, one in particular involving a CON EDISON duct bank under the Van Wyck Expressway.

When directional drilling holes are reamed to diameters sometime over 40 inches, the void created is very substantial and questionable as to abandoning it after pulling the service pipe(s). A solution to provide a sealed bore and protection for the pipe (if metallic) is to drill the pilot bore with conventional mud, and switch to IMPERMIX® slurry when reaming begins. IMPERMIX® ingredients are fine enough for the slurry to be cleaned on the same shakers while reaming is in progress. IMPERMIX® will remain fluid during the few days required for completing the bore and pulling the service pipe in its permanent sheath. Instead

of spending good money to dispose of the conventional mud being displaced by the pipe, displaced IMPERMIX® will set in a pit and will be disposed of as solid spoils.

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SPECIAL IMPERMIX® APPLICATION

It is nice to have a good track record: when one of the remediation contractors at the BRIO (TX) Superfund site was asked to seal in place a damaged deep monitoring well that was connecting various aquifers, the solution retained, to the immediate satisfaction of all responsible parties was to incase the well and its direct surroundings with one large column of jet grouted IMPERMIX®.

When a foundation contractor in Washington DC attempted to drive a steel sheet pile support of excavation along an old brick building, the building started to settle and a new method of sheeting placement had to be implemented: a 24 inch slot 9.5 feet wide and 62 feet deep was trenched under IMPERMIX® slurry and two pairs of sheeting were intalled almost against the building's spread footing. After setting overnight, an adjacent slot was excavated the next day, and the next double pair of sheets was placed threading the protected keyway. The vibration-less installation was successful and dripless.

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