Smart Foam Liquid Concentrate Solutions Series

WHITE PAPER

ABSTRACT

This white paper introduces project owners, developers, civil and geotechnical engineers, landscape architects, permit-granting agency staff, site preparation and pavement contractors, and other regulators and construction/project professionals to a new, more sustainable practice for improving stormwater runoff management: Pervious cellular lightweight concrete (PCLWC).

PCLWC improves the detention of stormwater runoff, providing more detention capacity than typical pervious fill solutions while imparting less impact on native soils, eliminating compaction testing, and significantly reducing project carbon dioxide emissions and heavy metal contamination to area wetlands and waterways.

Improving Stormwater Runoff Management

KEYWORDS

Sustainable development; green building; low impact development (LID); nonpoint source pollution (NSP); environmental compliance; pervious cellular lightweight concrete; stormwater runoff; infiltration; hydrocarbons; heavy metals; best management practices (BMP); retention; detention capacity; carbon dioxide emissions; clean water; permeable pavement; pervious concrete; porous asphalt; swales; detention ponds; soil loads; lightweight aggregate; pervious granular fill materials; pre-loading; slurry; Mearl Geofoam Pervious; and Cellular Concrete Solutions.

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BACKGROUND

Improving Stormwater Runoff Management

A leading cause worldwide of water quality problems is non-point source pollution (NSP), caused by runoff from rainfall or snowmelt moving over and through the ground. Population growth and economic development foster increases in the number of homes, businesses, roadways, and parking areas in a given watershed. The resulting extra impervious pavements and roofs prevent snowmelt and rain runoff from naturally soaking into native soils (infiltration).

As the runoff travels, it can pick up and carry away both man-made and natural pollutants, including oil, grease, chemical fertilizers, deicing salts, herbicides, insecticides, sediment, nutrients, and bacteria. If unchecked, the runoff can trigger many problems – erosion, floods, water table depletion, and the pollution of lakes, rivers, wetlands, and ground and coastal waters – and endanger drinking water supplies, farms, recreation areas, fisheries, and wildlife.

To comply with increasingly rigorous governmental regulations, municipalities around the world are adopting stronger stormwater management guidelines.

While communities struggle to strike a balance between economic growth and environmental issues, innovative construction materials can provide effective solutions for improving stormwater runoff detention and support sustainable development.

HISTORIC STORMWATER DETENTION BEST MANAGEMENT PRACTICES (BMP)

Growing public awareness, project owner dictates, and governmental directives have placed increased emphasis on green building practices, carbon dioxide emissions reduction strategies, and low impact, sustainable development. Over the past few decades, the environmental regulations municipalities, developers, and contractors must meet have become increasingly complex. Many governmental agencies are in the process of developing standards addressing methods to achieve specific environmental compliances. Participants from academia, government, environmental advocacy groups, and the private sector have formed groups to establish BMP.

In the area of stormwater runoff regulations, the objective of BMP is to keep NSP out of groundwater, wetlands and waterways by establishing construction and post-construction phase practices to meet existing environmental regulation requirements.

Construction phase practices for controlling stormwater runoff typically include: Protecting storm drain inlets; managing the storage, use, and disposal of fuels, chemicals, and construction materials to prevent them from polluting site runoff; eliminating sediment discharge from soil draining or drying activities; preventing construction vehicles from tracking job site sediment onto adjacent roadways; and reducing sediment in site runoff by a set amount (often 80%).

Post-construction phase practices typically include: Reducing suspended solids by a set amount (often 80%); managing vehicle fueling and maintenance areas to minimize petroleum/hydraulic runoff; reducing first-flush and peak runoff amounts during storms; providing protective areas between a development and adjacent waterways and wetlands; and allowing stormwater and snowmelt to infiltrate into native soil.

Ponds, swales and buffer zones, permeable pavements (pervious concrete, porous asphalt, or permeable pavers) and pervious fill materials are typical ways of controlling post-construction site runoff.

STORMWATER DETENTION WITH GRANULAR PERVIOUS FILL MATERIAL

Typical granular pervious fill materials have a detention capacity of approximately 2.4 gallons per cubic foot [320.7 liters per cubic meter]. If 1,000 gallons [3,785 liters] of stormwater runoff detention is required for the project, approximately 380 cubic yards [290.5 cubic meter] of native soil must be replaced or topped with granular pervious fill material. To minimize settlement, granular pervious fill materials are often installed in lifts, with each lift achieving 85% compaction. Many sites can require pre-loading of project areas for settlement mitigation, extending project schedules.

Note: While compaction reduces settlement, it also reduces the detention capacity of the compacted granular pervious fill material.

Where native soil project loads are a concern, typical granular pervious fill materials, which weigh approximately 110 pound per cubic foot (PCF) [1,760 kilogram per cubic meter], can be replaced with higher-cost, lightweight aggregate pervious fill, which weighs only about 90 PCF [1,440 kilogram per cubic meter]. To prevent settlement, lightweight aggregate pervious fill materials are often installed in lifts, with each lift achieving 85% compaction.

Note: Some cases where native soil loads are a concern, even

lightweight aggregate pervious fill materials must be reduced. In these cases, when pervious fill material is reduced, its detention capacity is also reduced, and most likely will not meet BMP guidelines.

The use of granular (or lightweight) pervious fill materials increases carbon dioxide emissions associated with the project and traffic congestion to and from the project site. Carbon emissions are created during both acquisition and installation of granular and lightweight pervious fill materials, including excavation of the raw materials, processing, stockpiling, loading, trucking to the project site, project site excavation, fill installation and compaction (in lifts), and compaction testing.

HISTORIC CELLULAR CONCRETE GEOTECHNICAL FILL MATERIALS

Cellular lightweight concretes have an established track record of success with project owners, public agencies, and geotechnical engineers and consultants, providing value-engineered solutions when standard fill materials are too heavy, site access is limited, or project schedules must be contracted.

Developed in Scandinavia in the early 1930s, typical cellular lightweight concrete fill is an engineered, impermeable lightweight material with a Portland cement base containing small, closed air cells uniformly distributed throughout the concrete. More precise control of the volume of these air cells, produced mechanically by means of special foam liquid concentrate agents, was introduced in the years following World War II, resulting in relatively stable air cells (bubbles) and controlled density for a broad range of load-reducing geotechnical fill needs – from 20 to 120 pounds per cubic foot (PCF) [320 to 1920 kilograms per cubic meter].

AN IMPROVED, MORE SUSTAINABLE STORMWATER DETENTION BEST MANAGEMENT PRACTICE IS NOW AVAILABLE

Recent innovation in foam liquid concentrate technology provides a new geotechnical fill solution for project owners, developers, civil and geotechnical engineers, landscape architects, and site preparation and pavement contractors: The production of pervious forms of cellular lightweight concrete (PCLWC).

PCLWC permits specifiers and contractors to control site bearing and drainage characteristics, and improves the detention of stormwater runoff, by providing more detention capacity than typical granular

pervious fill or lightweight aggregate solutions, while imparting less impact on native soils, eliminating pre-loading for project area settlement mitigation and compaction testing, and significantly reducing carbon dioxide emissions and heavy metal contamination to area wetlands and waterways.

Unlike typical cellular lightweight concrete, PCLWC is a permeable, open-cell, lightweight concrete, able to stabilize soil without disturbing or redirecting natural water flow.

PCLWC has a detention capacity of 4.8 gallons per cubic foot [641.3 liters per cubic meter]. For every 1,000 gallons [3,785 liters] of detention required, only 210 cubic yards [160.5 cubic meters] of native soil needs to be replaced or topped with PCLWC.

PCLWC is self-leveling and naturally achieves 100% compaction, eliminating settlement with no reduction in runoff detention capacity. It maintains its shape and detention capacity following placement and will not liquefy during a seismic event. Pre-loading for project area settlement mitigation is not required when using PCLWC. Unlike non-contained or non-homogeneous fill materials such as soil or aggregate, PCLWC provides the added benefit of gaining a 2-to-1 point-load-distribution edge.

The controlled density of PCLWC supports a broad range of load-reducing geotechnical fill needs – typically from 20 to 35 PCF [320 to 560 kilogram per cubic meter], which is significantly lighter than lightweight aggregate fill options (see above). PCLWC is 80% lighter than typical granular pervious fill options and requires 45% less volume, saving excavation and installation expenses and eliminating compaction and testing costs.

The use of PCLWC for stormwater runoff detention significantly reduces project carbon dioxide emissions. Projects with volumes exceeding 10,000 cubic yards [7,645 cubic meters] of detention fill use an on-site PCLWC batch plant that produces and pumps cementitious slurry, with trucking needed only for the delivery of cement. Such was the case in Queens, New York, during construction of Citi Field, new home of the New York Mets. More than 17,000 cubic yards of PCLWC were batched on-site, eliminating the need for a fill-truck staging area outside the stadium and removing more than 1,000 trucks from the Van Wyck Expressway, Grand Central Parkway, and other borough streets.

For projects with volumes of 10,000 cubic yards [7,645 cubic meters] or less, PCLWC production also happens on site, by treating

slurry manufactured at a local ready-mix plant and delivered and discharged by transit mixer to the hopper of a job site concrete pump. Engineered foam liquid concentrate (which enables the production of PCLWC) is injected into the delivered slurry in the pump hose – not the transit mixer.

This method expands the volume of the delivered slurry about 3.8 times (one seven cubic-yard slurry load producing 27 cubic yards of PCLWC), eliminating up to 55% of the trucks required (and the accompanying road traffic congestion), had a granular pervious fill option been used.

Both PCLWC batching methods can incorporate ground granulated blast-furnace slag or fly ash in the slurry mix design without adversely affecting PCLWC performance. The use of these post-industrial byproducts in PCLWC production eliminates the need to landfill these materials and reduces the need for virgin materials in PCLWC production, and the environmental impacts from the extraction and processing of virgin materials.

Testing by Middle Tennessee State University documents the ability of PCLWC to enhance the environment by filtering contaminants that can adversely affect soil and water.

Various chemicals and solids were placed on PCLWC specimens and then rinsed with increasing amounts of water – 0.5 to 30.0 inches [1.27 to 76.2 centimeters] – over a given surface area. Testing results showed PCLWC filtered 78% of the hydrocarbons and heavy metals. Testing for oil retention resulted in 97% of oil remaining on the PCLWC specimen.

PCLWC creates an ideal environment within its cell structure to aid in the natural breakdown of environmentally unfriendly materials. Hydrocarbons – such as oils – are a food source for many naturally occurring bacteria and fungi. The cell structure of PCLWC allows these microorganisms to feed on the retained oil and biodegrade it into simpler chemical components, which are released harmlessly into the atmosphere.

MEARL GEOFOAM PERVIOUS™ ENABLES THE PRODUCTION OF PCLWC

In 2008, Mearl Geofoam Pervious, the patent-pending, innovative foam liquid concentrate that makes PCLWC technology possible, was named Most Innovative Product, Concrete Making Materials Category, by

LINKS TO ADDITIONAL INFORMATION ABOUT PERVIOUS CELLULAR LIGHTWEIGHT CONCRETE:

FREQUENTLY ASKED QUESTIONS

CASE STUDY: CITI FIELD

MEARL GEOFOAM PERVIOUS™ CUT SHEET

MEARL GEOFOAM PERVIOUS™ MATERIAL SAFETY DATA SHEET

World of Concrete (WOC) attendees and a panel of WOC-assembled industry experts, the only product, out of 144 entries, to win both the attendees' and experts' choice Most Innovative Product awards.

CONCLUSION

While progress has been made worldwide in reducing direct water pollution from industry and sewage treatment systems, non-source pollution continues to put the planet's watersheds at risk. Historic stormwater runoff detention practices have established construction and post-construction phase BMP to meet existing environmental regulation requirements.

Innovative construction technology now provides a more sustainable practice for improving stormwater runoff detention: Pervious cellular lightweight concrete (PCLWC).

PCLWC improves the detention of stormwater runoff, providing 45% more detention capacity than typical pervious fill solutions while imparting less impact on native soils (45% less excavation required), eliminating compaction testing, and significantly reducing carbon dioxide emissions and heavy metal contamination to area wetlands and waterways.

NEXT STEPS

More information about PCLWC is available online at: www.cellular-concrete.com.

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ABOUT CELLULAR CONCRETE SOLUTIONS

Cellular Concrete Solutions engineers integrated, smart foam liquid concentrate solutions for construction, mining, and manufacturing applications, applying research, innovation, and technical expertise and support to help specifiers, contractors, and manufacturers expand markets, improve quality and job site safety, and reduce project/ environmental costs.

The innovative Cellular Concrete Solutions product line includes protein, synthetic, and protein/synthetic blend liquid foam concentrate formulations for use in insulated concrete roof deck and floor construction, low slump and lightweight concrete applications, and mining and geotechnical applications, including pervious cellular lightweight concretes.

The engineered foams are designed to release their unique physical properties only when mixed with the cementitious materials and a chemical reaction occurs. Construction professionals find Cellular Concrete Solutions' smart foaming agents to be the most stable pre-formed products in the cellular concrete industry, durable cell structures not affected by long pump runs, extended mixing, or most fly ashes or ground granulated blast-furnace slags.

Pre-formed smart foaming agent products include:

- Mearl 40™ - for low-density, insulated concrete roof deck and floor applications
- Mearl Geofoam 40 Non Pervious™ - for low-density geotechnical construction applications
- Mearlcell 3532-40™ - for pre-cast construction applications
- Mearl Transport™ - for surface tailings disposal and backfilling
- Mearl Geofoam Non Pervious™ - for geotechnical, grouting and tremie applications
- Mearl Geofoam Pervious™ - for pervious geotechnical applications
- CellFlow™ - for the production of CLSM materials (flowable fill)

Cellular Concrete Solutions also sells foam generation systems designed specifically for producing consistent foam for cellular concrete production, including jobsite-tough tank generators, tankless auto generators, and portable lab-foam generators for producing accurate results in the laboratory.

More information about patent-pending Mearl Geofoam Pervious and Cellular Concrete Solutions is available online at www.cellular-concrete.com.