

## WHAT FACTORS ARE IMPORTANT IN CONCRETE PIPE MANUFACTURING?

There are several methods of manufacturing concrete pipe. Depending on the process, slag cement proportioning may vary. Certain factors, however, are important to the manufacturers of all concrete pipe:

- Strength at early ages
- Surface texture and density
- Permeability
- Sulfate resistance
- Consistency

Slag cement is an ideal material for concrete pipe because it can positively affect all of these factors.

## HOW DOES SLAG CEMENT AFFECT STRENGTH?

Heat is a great activator for slag cement. Since most concrete pipe manufacturers use heat to cure their products, early age strength is usually equivalent or superior to straight portland cement concrete. At 28 days, strengths are superior when concrete pipe is manufactured with slag cement.

## HOW DOES SLAG CEMENT AFFECT PERMEABILITY?

When slag cement is used as part of the cementitious material in a concrete mixture, it reacts with calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ) to form additional calcium silicate hydrate (CSH). CSH is the glue that provides strength and holds concrete together. The additional CSH produced modifies the pore structure of the paste resulting in lower permeability. The level of improvement is proportional to the percentage of slag cement in the mixture.



*Stockpiled concrete pipe, manufactured with slag cement.*

## HOW DOES SLAG CEMENT AFFECT SURFACE TEXTURE AND DENSITY?

Slag cement improves surface texture and density. The fine grind and glassy structure of slag cement provides a surface that is tighter and smoother. This results in concrete pipe that has fewer surface voids and fits into place with more precision.

*Slag cement is an ideal material for concrete pipe because it can improve the factors most important in concrete pipe manufacturing.*

*Early age strength is usually equivalent to or greater than portland cement concrete when heat curing is used.*

## PRODUCING CONCRETE PIPE WITH SLAG CEMENT

### HOW DOES SLAG CEMENT AFFECT SULFATE RESISTANCE?

Concrete pipe is often exposed to harsh local environments. Sulfate attack occurs in hardened concrete when sulfates, found in seawater, in some soils and in wastewater, reacts with the tricalcium aluminate ( $C_3A$ ) in portland cement paste. The reaction causes a material called ettringite to form. Ettringite can cause concrete to expand and prematurely deteriorate. The higher the  $C_3A$  of the cement, the greater the potential for sulfate attack. Slag cement does not contain  $C_3A$  so the higher the percentage of slag cement used, the lower the  $C_3A$  of the mixture and the lower the potential for deleterious expansion. Additionally, slag cement reduces the permeability of the concrete and limits the ability of sulfates to penetrate into the concrete.

### HOW DOES SLAG CEMENT AFFECT CONSISTENCY?

Slag cement is one of the most consistent materials used in concrete. Since it is made in a manufacturing process, chemical composition and particle size are controlled during its production, ensuring not only conformance with specifications, but also low variability from shipment to shipment, and even from source to source. Slag cement does not contain carbon and maintains a consistent particle size, thus ensuring a stable air void system. Concrete pipe manufacturers can depend on slag cement to help reduce the variability of their concrete materials.



Concrete pipe manufactured with slag cement.

### PROPORTIONING CONCRETE PIPE MIXTURES WITH SLAG CEMENT

Concrete pipe manufacturers who have successfully incorporated slag cement in their products have used slag cement in ranges from 20 to 50 percent of cementitious material.

*As with all concrete mixtures, trial batches should be performed to verify concrete properties. Results may vary due to a variety of circumstances, including temperature and mixture components, among other things. You should consult your slag cement professional for assistance. Nothing contained herein shall be considered or construed as a warranty or guarantee, either expressed or implied, including any warranty of fitness for a particular purpose.*

### About the Slag Cement Association...

The Slag Cement Association is the leading source of knowledge on blast-furnace slag-based cementitious products. We promote the increased use and acceptance of these products by coordinating the resources of member companies. We educate customers, specifiers and other end-users on the varied attributes, benefits and uses of these products.

*The use of slag cement reduces concrete permeability and susceptibility to sulfate attack.*



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