

High thermal stresses in mass concrete can result in cracking and loss of structural integrity.

When slag cement is incorporated in a concrete mixture, less heat is generated and thermal stress is reduced.

WHAT IS MASS CONCRETE?

According to ACI 207, “**mass concrete** is any large volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat and attendant volume change to minimize cracking.” Cement hydration generates heat. Heat dissipates from concrete slowly; the thicker the section, the longer it will take the interior to cool. This can result in large temperature differentials between the concrete surface and its interior. The concrete is then subject to high thermal stresses, which can result in cracking and loss of structural integrity.

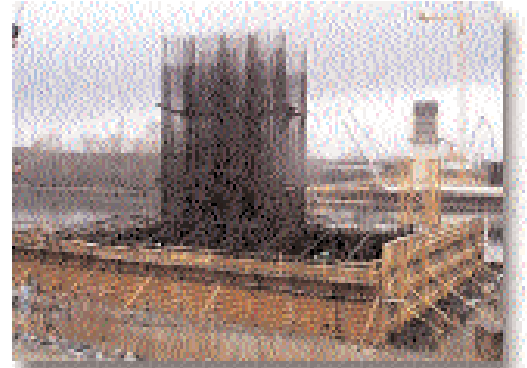


Figure 1: The 16-foot thick footings on the Pocahontas Parkway in Virginia used 75% slag cement with Type II portland cement to reduce concrete peak and differential temperatures.

REDUCING THERMAL STRESS

There are three generally accepted strategies for reducing thermal stress in concrete:

- Reduce the total cementitious content
- Reduce the portland cement content
- Slow down the hydration process through the use of various admixtures or cooling the concrete.

HOW DOES SLAG CEMENT HELP?

When slag cement is incorporated in a concrete mixture, less heat is generated and thermal stress is reduced:

- Due to increased strength with slag cement, the total cementitious content can be reduced
- Portland cement content is reduced by the percentage of slag cement used
- Hydration characteristics of slag cement are such that the early rate of heat generation and peak temperature of the concrete are reduced.

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.

REDUCING THERMAL STRESS IN MASS CONCRETE

SLAG REPLACEMENT LEVELS

Generally 65 to 80 percent is considered an optimum replacement range for mass concrete applications. These levels typically provide significant heat reduction while achieving desired strengths. Levels from 50 to 65 percent have been used successfully in smaller mass concrete placements. Mixtures should be tested with job materials to ensure required thermal and strength characteristics.

Figure 2 shows the specific heat of hydration of an ordinary portland cement and combinations from 25 to 75 percent slag cement substitution. Note that each increasing level of slag cement reduces peak heat of hydration of the

binder. More importantly, the area under each curve represents total heat generated. This area reduces dramatically when the substitution rate increases from 50 to 75 percent, indicating that significantly less total heat is generated for 75 percent slag cement, even though the peak heat of hydration is not much reduced from 50 percent substitution.

Figure 3 shows the effect of slag cement on temperature rise in mass concrete. Note that peak temperature dropped by 19 degrees F with 65 percent slag cement substitution, and by 42 degrees F for 80% substitution.

Figure 2: Effect of Slag Cement on Heat of Hydration

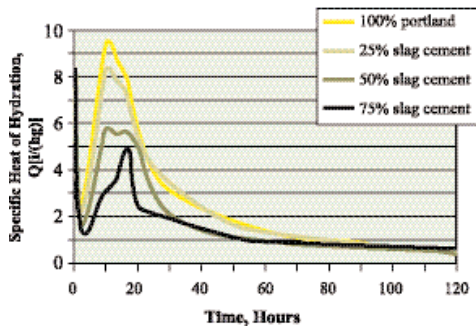
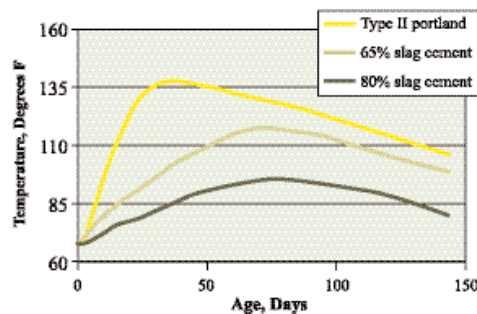


Figure 3: Effect of Slag Cement on Temperature Rise in Mass Concrete



Reference

1. ACI 207.1R-97, *Mass Concrete*; Concrete Institute, Farmington Hills, Michigan, 1992.

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.

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Slag Cement Association
38800 Country Club
Farmington Hills, MI 48331

phone: 847.977.6920
e-mail:
info@slagcement.org
web:
www.slagcement.org