SCA SLAG CEMENT ASSOCIATION

Information Sheets

20: Ternary Concrete Mixtures with Slag Cement

What Are Ternary Concrete Mixtures?

Ternary concrete mixtures include three different cementitious materials. This report addresses those combinations of portland cement, slag cement, and a third material. The third component is often fly ash, but silica fume is not uncommon.

ASTM C595 binary blended hydraulic cement used in combination with a third cementitious material is also considered a ternary mixture. Other materials in combination with portland and slag cement, such as metakaolin or rice husk ash, are not currently in common usage and will not be discussed here.

Ternary mixtures can also be made with ASTM C595 ternary blended cement.

Slag cement has been used in ternary mixtures for decades. For example, the Empire State Building was constructed using combi- nations of slag cement, portland, and lime in the masonry.

What Are the Benefits of a Ternary Mixture?

Ternary mixtures can be designed for:

- High strength
- Corrosion resistance
- ASR resistance
- Elimination of thermal cracking
- Low permeability
- Sulfate resistance
- Reduction of carbon footprint

Compressive strengths exceeding 10,000 psi were achieved in 1989 in the construction of Scotia Plaza in Toronto, ON, Canada. More recently, compressive strengths over 13,000 psi were attained in NRG Stadium (figure 1). The mixture designs are displayed in Table 1

Where Can Ternary Blends Be Used?

Ternary mixtures can be used—and have been used—in virtually any concrete application.

- General construction (residential, commercial, industrial)
- High-performance concrete
- Masonry and masonry units
- Shotcrete
- Paving
- Precast concrete
- Mass concrete
- Soil stabilization

Can Ternary Blends Be Used in Exterior Concrete Exposed to Freezing and Thawing?

Ternary blends have been and continue to be used in concrete exposed to freezing and thawing and de-icing chemicals. Proper air entrainment, adequate curing, and good concrete finishing practices will maximize the ability of any concrete to resist freezing and thawing and de-icing chemicals. Many different mixture proportions have been used with good results. Paving projects with ternary mixtures have performed for many years in severe conditions with no apparent loss of durability.

Table 1 – Concrete Mixture Designs

	Scotia Plaza		NRG Stadium	
Cementitious Component	lb/yd³	% of Total Cementious	lb/yd³	% of Total Cementious
Portland	530	65%	450	50%
Slag Cement	228	28%	270	30%
Silica Fume	60	7%	0	0%
Fly Ash	0	0%	180	20%

Figure 1: NRG Stadium (NFL) in Houston, TX, which opened in 2002, used a portland-slag cement-fly ash mixture to achieve both high strength and low heat of hydration in its four massive "super columns," supporting the retractable roof.

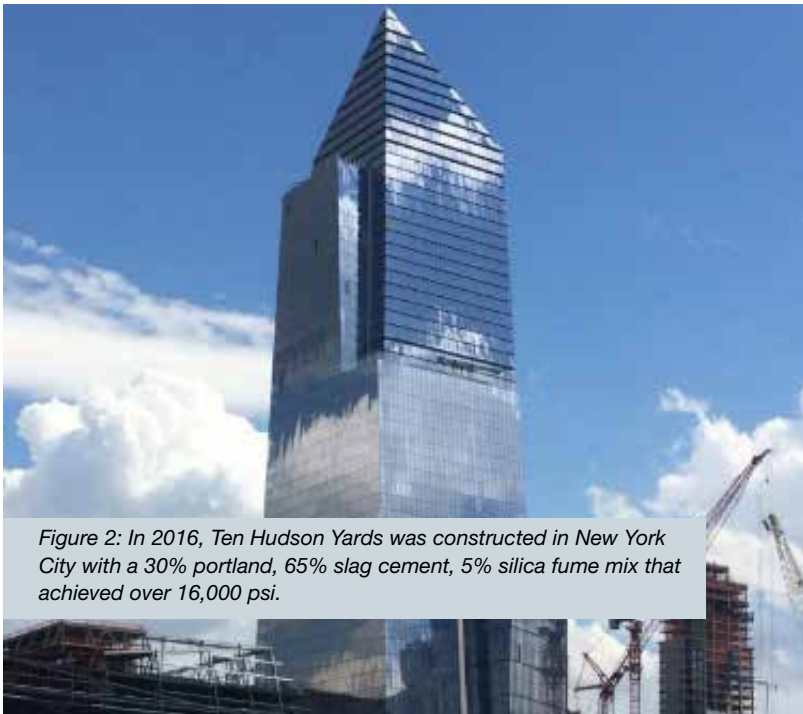

Figure 2: In 2016, Ten Hudson Yards was constructed in New York City with a 30% portland, 65% slag cement, 5% silica fume mix that achieved over 16,000 psi.

SCA
SLAG CEMENT
ASSOCIATION

38800 Country Club Dr
Farmington Hills, MI 48331

(248) 848-3813
info@slagcement.org
www.slagcement.org

Ternary blends have been used in general construction, high performance concrete, paving, precast, mass concrete, masonry and masonry units, and shotcrete.

What Mixture Proportion Should Be Used?

The optimum supplementary cementitious proportions for ternary blends, as with any concrete mixtures, will be dependent on the intended application of the concrete, construction requirements and seasonal considerations. As with other concrete, cold weather will affect the early strength gain and mixture proportions and may require some adjustments to assure jobsite performance.

In low w/cm applications such as paving, mixtures with 15% fly ash and 30% slag cement component have been used success fully. One World Trade Center in New York City utilized a mixture that contained 52% slag cement along with portland cement, fly ash, and silica fume to control heat gain and achieve strengths exceeding 14,000 psi.

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.

Figure 3: One World Trade Center utilized a mixture that contained 52% slag cement with portland, fly ash, and silica fume to control heat gain and achieve a 14,000 psi requirement..