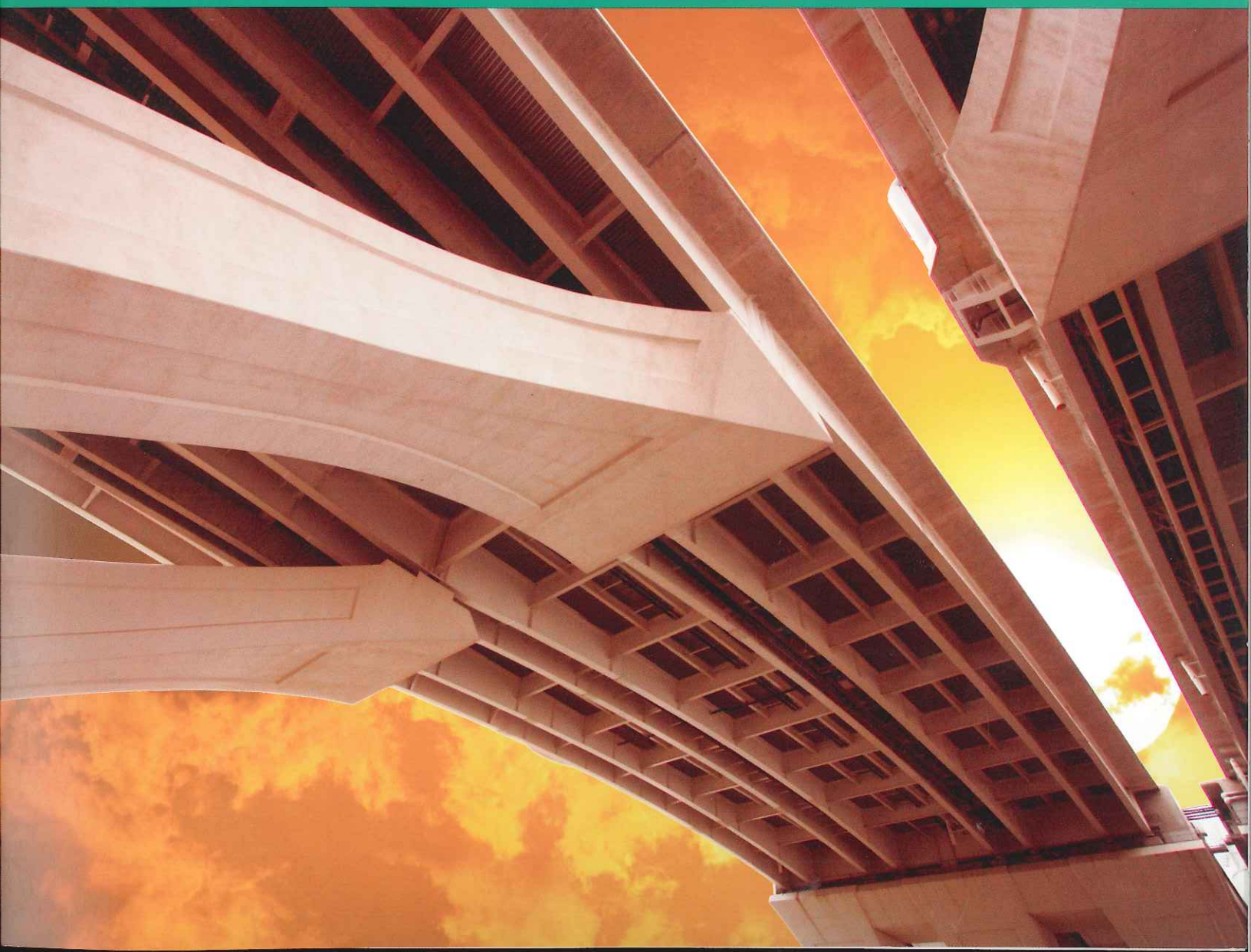
AGGREGATE INDUSTRIES

Delivering Value

Emerald™ SERIES

High Volume Fly Ash Concrete



Emerald™ SERIES HIGH VOLUME FLY ASH CONCRETE

INTRODUCTION TO HIGH VOLUME FLY ASH CONCRETE

The use of concrete containing high volumes of fly ash has recently gained popularity as a resource-efficient, durable, and sustainable option for a variety of concrete applications. Consisting mostly of silica, alumina, and iron, High Volume Fly Ash Concrete creates a stronger, more durable product and reduces concrete's environmental impact considerably.

Emerald Series™ is a new generation of concrete designed to reduce the carbon footprint using post industrial waste, post consumer waste, recycled concrete, locally harvested raw materials, and pervious concrete designed for storm water management.

Emerald Series™ Products	Environmental Attributes	LEED Category	LEED Credits Product Contributes To
High SCMs Concrete Moderate SCMs Concrete	• Higher percentage of recycled content • Reduced carbon content by minimizing amount of portland cement • Increased durability	• Materials & Resources • Innovation In Design	• **MR 4 Recycled Content** 10% (1 Point) or 20% (2 Points) • **MR 5 Regional Materials** 10% (1 Point) or 20% (2 Points) • **ID 1.1 Innovation In Design** (1 Point)

SCMs: Supplementary Cementing Materials - locally produced and reused material, reduced carbon emissions; **MR**: Materials and Resources; **ID**: Innovation in Design

Emerald Series™ can also contribute toward **Regional Priority Credits**. Regional Priority Credits incentives the achievement of credits that address geographically specific environmental priorities. If a Regional Priority Credit is earned, then a bonus point is awarded to the project's total points. Check with your local USGBC chapter to see what Regional Priority Credits are available in your area.

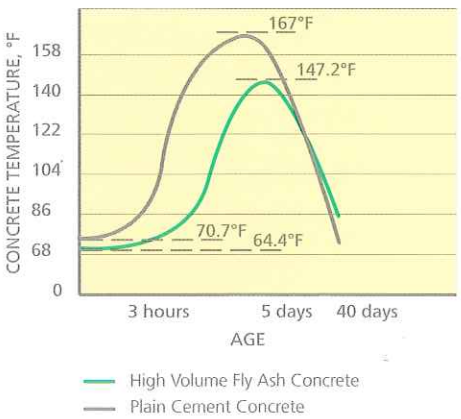
HOW HIGH VOLUME FLY ASH CONTRIBUTES TO CONCRETE WORKABILITY

- High Volume Fly Ash produces more paste. It has a lower specific gravity which means on a pound for pound basis it contributes about 30% more volume of cementitious material per pound versus cement
- High Volume Fly Ash reduces the amount of water needed to produce a given slump. The spherical shape of Fly Ash particles and their ability to disperse typically reduces the water by 2% to 10%
- High Volume Fly Ash makes concrete easier to pump and reduces segregation
- High Volume Fly Ash Improves finishing

HOW HIGH VOLUME FLY ASH REDUCES HEAT OF HYDRATION

The hydration of cement is an exothermic reaction. Heat is generated very quickly, causing the temperature to rise and accelerating the setting time and strength gain. Many situations exist where the rapid heat gain of cement increased the chances of thermal cracking, leading to reduced concrete strength and durability. In these applications where mass concrete is required, it is extremely beneficial to use large percentages of fly ash that can reduce the damaging effects of thermal cracking - typically 35% as much heat as compared to cement at early ages.

CONCRETE TEMPERATURE COMPARISON



Emerald™ SERIES

HIGH VOLUME FLY ASH CONCRETE

BENEFITS AT GLANCE

Workability

- Improved workability
- Ease of pumping
- Improved finishing
- Reduced bleeding
- Reduced segregation

Performance

- Higher ultimate strength
- Decreased permeability
- Reduced sulfate attack
- Reduced shrinkage
- Reduced alkali silica reaction
- Reduced heat of hydration
- Reduced efflorescence

Environment

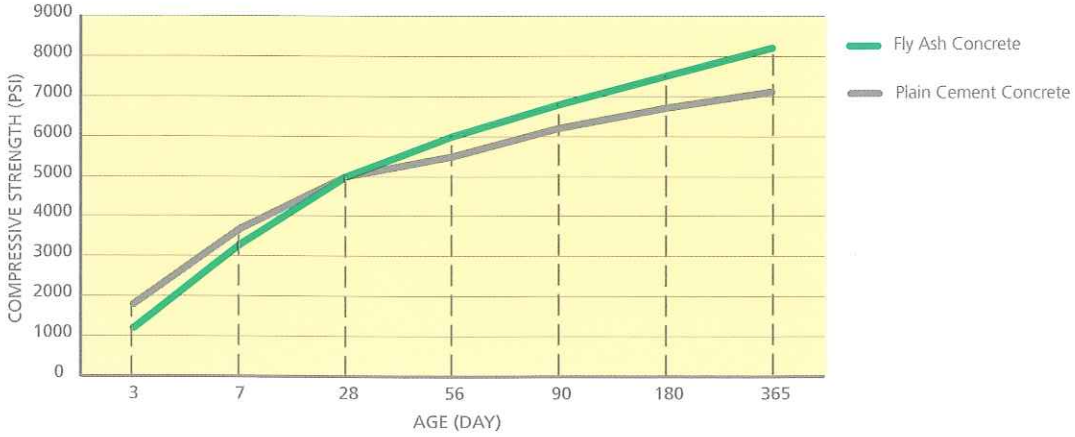
- Conserved landfill space
- Reduced CO_2 emission
- Saved energy
- Reduced raw material extraction

HOW HIGH VOLUME FLY ASH CONTRIBUTES TO CONCRETE DURABILITY AND STRENGTH

Durability and strength are not synonymous when talking about concrete: durability is the ability to maintain integrity and strength over time; strength is only a measure of the ability to sustain loads at a given point in time. Two concrete mixes with equal cylinder strength of 4000 psi at 28 days can vary widely in their permeability, resistance to chemical attack, resistance to cracking and general deterioration over time, increases sulfate resistance and reduces alkali silica reactivity (Class F) – all of which are important to durability.

Cement normally gains most of its strength within 28 days, thus the reasoning behind specifications normally requiring determination of 28-day strengths as a standard. As lime from cement hydration becomes available, it reacts with High Volume Fly Ash. Typically concrete made with High Volume Fly Ash will be slightly lower in strength up to 28 days, equal at 28-days, and substantially higher within a year's time. Conversely, in straight cement concrete, this lime would remain intact and, over time, would be susceptible to the effects of weathering, chemical attack, and loss of strength and durability. It is good practice to specify 56-day strength when using High Volume Fly Ash concrete.

TYPICAL FLY ASH CONCRETE STRENGTH DEVELOPMENT



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