SCA SLAG CEMENT ASSOCIATION

Information Sheets

22: Slag Cement's Role in Sustainable Construction

Recovering a Valuable Product

Blast-furnace slag is a non-metallic mineral material produced in a blast furnace during the conversion of iron ore into molten iron, which is often disposed of in landfills as waste. When separated from the molten iron and quenched with water, molten slag vitrifies into a Granulated Blast-Furnace Slag (GBFS). This quenching process greatly reduces a blast-furnaces' harmful emissions and results in a useful byproduct. In addition, when dried and ground into a fine powder GBFS becomes a Ground Granulated Blast-Furnace Slag (GGBFS) or Slag Cement. Using slag cement as a partial replacement for portland cement in concrete reduces virgin material use and lowers the overall embodied energy needed to produce a yard of concrete.

How Does Slag Cement Make Concrete Greener?

Concrete is an inherently green material that has many benefits which contribute to sustainable construction practices. Slag cement helps enhance concrete's benefits.

- **Climate Change**

Slag cement, when used in concrete mixes, helps minimize carbon emissions which contribute to climate change as demonstrated in Figure 1. When compared to standard concrete mixes, those containing slag cement have a lower embodied carbon.

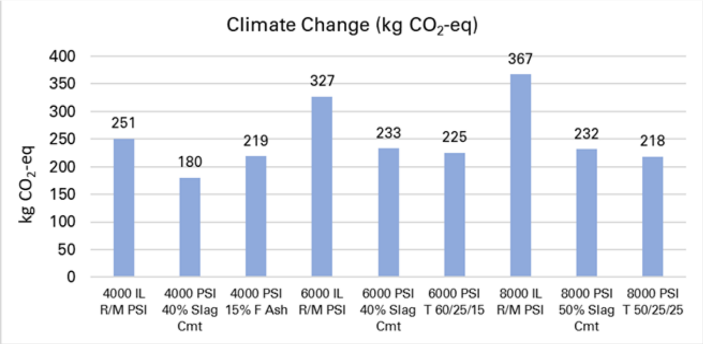

Figure 1: Effect of slag cement on the reduction of embodied CO_2.

- **Waste Reduction**

Slag cement is a byproduct, that if not beneficially used in concrete, will often be landfilled as waste. From ACI 233 (9.1-Slag Cement and Sustainability): "Slag cement is an industrial byproduct that originates during production of iron in a blast furnace. Through granulation and grinding, slag cement captures and makes available the materials and energy that would otherwise be wasted if slag were disposed of. Slag cement is therefore regarded as a recovered industrial material, and its use makes concrete a more sustainable product."

- **Resource Conservation**

When slag cement is used, less portland or blended portland cement is needed, which lowers the demand for virgin extracted materials. Producing one ton of portland cement requires about 1.6 tons of raw material because of mass loss due to cement clinker calcination. Figure 2 shows the non-renewable energy requirements for producing various types of standard and high performance concrete mixes. Mixes containing slag cement are inherently less raw material intensive because the use of virgin raw materials is reduced. From ACI 233 (9.2-High volume slag cement use in concrete): "One of the benefits of slag cement, from a sustainable perspective, is that the replacement of large proportions of portland cement with slag cement in concrete is a commonly accepted industry practice. Because portland cement is the largest contributor in concrete to embodied greenhouse gases and energy, higher substitution levels can significantly reduce these components in concrete."

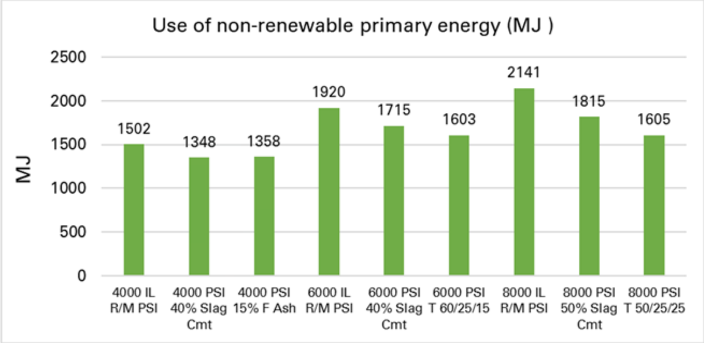

Figure 2: Effect of slag cement on the reduction of non-renewable primary energy usage.

- **Enhanced Longevity**

Slag cement improves the service life of concrete structures through enhanced durability. This is achieved through lower permeability, corrosion resistance, improved resistance from sulfate attack and alkali-silica reactivity (ASR), and reduced thermal stress cracking.

- **Energy Conservation**

The energy requirements for producing slag cement are nearly 90 percent less than that producing the equivalent amount of portland cement. Reducing the use of portland cement in concrete by substituting a portion of it with slag cement significantly reduces the embodied energy in concrete, since portland cement constitutes 70 percent or more of the embodied energy in concrete.

- **Role in Reducing Carbon Emissions**

Carbon dioxide (CO_2) is classified as a green-house gas. In portland cement manufacturing, about .9 tons of CO_2 is released for every ton of portland cement produced. The cement industry has reduced CO_2 emissions significantly since the early 1980s and continues to develop methods that minimize the release of greenhouse gases. One approach is by offering alternative cementitious materials, like slag cement, to partially replace portland cement in concrete mixtures. Figure 3 illustrates the reduction in CO_2 from substituting slag cement and fly ash in various concrete mixtures with portland-limestone cement.

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Utilization of slag cement in concrete lessens the burden on landfills, reduces emissions, and conserves energy

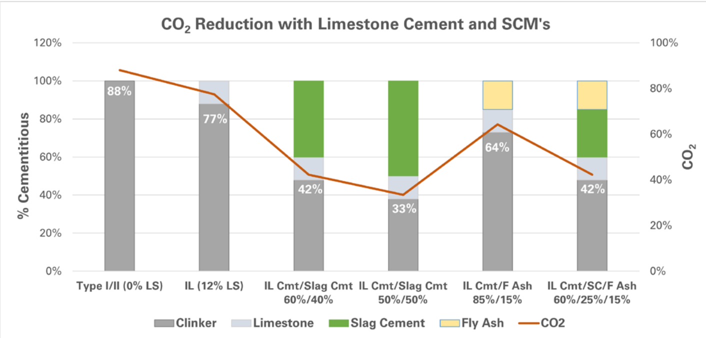
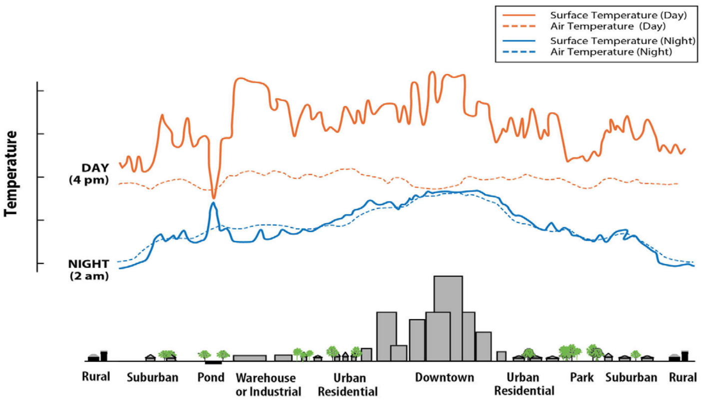


Figure 3: Effect of SCMs with portland-limestone cement on the reduction of embodied CO_2.

- **Reduced Heat Island Effect**

The Environmental Protection Agency (EPA) describes heat islands as, "Urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas. Daytime temperatures in urban areas are about 1–7°F higher than temperatures in outlying areas and nighttime temperatures are about 2–5°F higher."

The lighter color of slag cement concrete helps reduce the heat island effect. Since urban areas have a higher concentration of structures and dark surfaces that absorb heat, they experience higher temperatures than their rural neighbors do. Lighter colored buildings and pavements reflect more light. This helps minimize the heat island effect, which reduces the energy needed for cooling, and results in lower ozone levels.



An illustration from the U.S. Environmental Protection Agency highlighting the impact of different land uses to the air and surface temperatures of a city.

- **Green Building Rating Certifications**

The utilization of slag cement on a project can help it achieve certifications such as LEED®, Green Globes, and other sustainability initiatives. From ACI 233 (9.7-Green building rating systems): "Many green building rating systems have been developed worldwide to provide quantitative measures that determine whether a building is green."

EPA Guidance for Federally-Aided Projects

In 1996 the EPA recognized slag cement as a recovered material under the Federal Resource Conservation Recovery Act. This classification requires that slag cement be specified in concrete on federally funded projects, while also considering performance requirements and availability. For more information on the EPA's Comprehensive Procurement Guidelines a key component of the federal government's "Buy Recycled" program visit the website: https://www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products#04

References

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