Concrete Atlantic béton Atlantique

Concrete Tech-Tip #27
Low Carbon Concrete

What is Low Carbon Concrete?

Low carbon concrete refers to concrete mixtures specifically designed to reduce embodied carbon or global warming potential (GWP) while maintaining required mechanical and durability performance.

Strategies to Reduce Embodied Carbon

There are many pathways the concrete industry is taking to lowering concrete related emissions, including improving cement plant efficiency, optimizing structural design, encouraging carbon uptake over the service life, and modifying concrete mixtures to reduce clinker content. This tech tip focuses on material and mixture strategies used by ready mix and precast producers.

Reducing Clinker Content

In Atlantic Canada, most concrete producers rely on portland-limestone cement combined with supplementary cementing materials and blended cements to reduce embodied GWP in concrete. Portland limestone cement has largely replaced ordinary portland cement in Canada.

Portland-limestone cement contains up to fifteen percent interground limestone, compared to a maximum of five percent in traditional ordinary portland cement. This increased limestone content reduces clinker content and associated emissions, while maintaining equivalent performance when properly manufactured. The reduction in GWP emissions is approximately 7%.

Supplementary cementing materials including fly ash, slag and silica fume are also commonly used in concrete mixture designs.

Fly ash is the most widely used supplementary cementing material in Atlantic Canada. Fly ash is commonly used at replacement levels of fifteen to twenty five percent, with higher levels often used in mass concrete applications to reduce heat generation. Benefits include improved long-term strength, reduced permeability, enhanced durability, and lower global warming potential.

Silica fume is also used, particularly in structures exposed to aggressive environments. Blended cements are another option, especially where silo space is limited. A notable example is the Confederation Bridge, where concrete mixtures incorporating both fly ash and silica fume were designed to meet high strength requirements and achieve a one-hundred-year service life in a severe marine environment.

How to Identify a Low Carbon Concrete Mixture
Low carbon concrete is typically defined relative to a regional baseline value. The key metric used is global warming potential, reported in kilograms of carbon dioxide equivalent.

This value is documented in an Environmental Product Declaration (EPD) for a specific concrete mix. EPDs are generated using life cycle assessment tools that account for material quantities, constituent sources, and transportation distances. Mix specific EPDs allow direct comparison to regional baseline documents.

Project specifications often require a defined percentage reduction below baseline. In many cases, this reduction can be achieved using local aggregates, portland-limestone cement, supplementary cementing materials, and conventional admixtures, without the need for specialty materials.

On larger or multi year projects with multiple mixtures, tracking and balancing global warming potential across all placements may be required. In these cases, consultants are often engaged to support mixture optimization and documentation throughout construction.

What Limits Broader Adoption

Prescriptive specifications remain one of the primary barriers to broader implementation of low carbon concrete. Requirements that restrict cement types, supplementary cementing material replacement levels, or materials can prevent optimization, even when performance would not be compromised.

Performance based specifications encourage innovation and flexibility, allowing engineers and suppliers to meet strength, durability, and service life requirements while reducing environmental impact.

References

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