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CARBON FOOTPRINT

INTEGRATED PAVING SOLUTIONS

WHAT IS IT?

Loosely defined, a carbon footprint is a measure of how many greenhouse gas (GHG) emissions a person, organization, event, or product produces. However, carbon footprints are often simplified by measuring the amount of carbon dioxide (CO_2) produced.

Carbon dioxide and other gases exist naturally in the atmosphere. These gases retain the sun's heat and create the atmosphere that sustains life on earth.

However, burning fossil fuels adds unnatural amounts of CO_2 and other gases into the air. These have the potential to trap heat, raise air temperatures, and change the balance of life on earth – effectively leaving a "footprint."

The primary source of human-generated CO_2 emissions is fossil fuel power plants, which contribute to 35 percent of all CO_2 emissions. In the U.S., passenger vehicles and light trucks account for another 20 percent. U.S. cement manufacturing accounts for less than 1.5% of all U.S. human-generated CO_2 emissions.*

Although CO_2 is often singled out, a number of other human-generated pollutants are included in the carbon footprint equation. Pound for pound, these other emissions have a much greater effect on global warming than CO_2. Examples include methane, nitrous oxide, and chlorofluorocarbons. One pound of methane has the same global warming effect as 22 pounds of carbon dioxide in the atmosphere.

Cement, Concrete, and CO_2

When evaluating the carbon footprint of concrete pavements, it is important to recognize the difference between cement and concrete. While cement is an energy-intensive product, concrete is actually one of the world's most CO_2-efficient and sustainable construction materials.

CO_2 emissions from a cement plant are divided into two source categories:

- Combustion (40 percent of emissions)
- Calcination (60 percent of emissions)

The combustion-generated CO_2 emissions are related to fuel use. The CO_2 emissions due to calcination are formed when the raw materials (mostly limestone and clay) are heated to more than 2500°F and CO_2 is liberated from the decomposed minerals.

During the life of a concrete pavement, the concrete that is exposed to air slowly absorbs nearly 60 percent of the CO_2 released by calcination during the cement manufacturing process (Nordic Innovation Centre Project 03018). The carbonation process continues even after the pavement is demolished and the concrete is crushed and reused.

The focus of reductions in CO_2 emissions during cement manufacturing is on energy use, and the cement industry is striving to continuously reduce its CO_2 contribution.

** From industrial sources only, cement accounts for less than 3% of U.S. CO_2 emissions, well below other materials such as petroleum (21.8%), chemicals (22.2%), and iron/steel (9%).*

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Putting CO_2 Emissions into Perspective

The manufacture of cement produces about 0.9 pounds of CO_2 for every pound of cement. Since cement is only a fraction of the constituents in concrete, manufacturing a cubic yard of concrete (about 3900 lbs) is responsible for emitting about 400 lbs of CO_2.

The release of 400 lbs of CO_2 is approximately equivalent to:

- The CO_2 associated with using an average tank of gas in a car
- The CO_2 associated with using a home computer for a year
- The CO_2 associated with using a microwave oven in a home for a year
- The CO_2 saved each year by replacing 9 light bulbs in an average house with compact fluorescent light bulb

Considering Life-Cycle Assessment

When comparing construction alternatives, an environmental life cycle assessment (LCA) provides a level playing field. An LCA is based on a consistent methodology applied across all products and at all stages of their production, transport, energy use, maintenance, and disposal or recycling at end of life. A full LCA includes the impacts of energy use and associated emissions during the life of the product or structure, not just construction.

A 2006 study by the Athena Institute studied embodied primary energy and global warming estimates for the construction and maintenance of equivalent concrete and asphalt pavement structures. The study accounted for original road construction and all maintenance and rehabilitation activities for both pavement alternatives.

Results show that asphalt pavements require two to five times more energy than equivalent concrete pavement alternatives.

Additional Considerations:

- Concrete is a locally produced material shipped only short distances – another environmental and energy saving plus. Its primary components, sand and gravel or crushed stone, are universally available materials.
- Concrete lasts longer. State DOT records demonstrate that asphalt pavements need major reconstruction at an average age of 13.6 years, compared to more than 29 years for concrete.
- Vehicles traveling on concrete pavements have statistically significant lower fuel consumption than those traveling on flexible asphalt pavements.
- A concrete pavement requires less illumination at night, further decreasing concrete's carbon footprint.

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