

LOWERING CO2 IN SLAB CONSTRUCTION

The RPS Foundation Forming System: A solution to significantly lowering CO2 in slab construction

By Mel Kimsey

I've been excited by technology, and especially as it relates to innovations in an industry's existing processes. I have worked for several high-tech companies since 1977, including managing, owning, investing, and as an advisor in the field. These included companies in the fields of medical, hardware and software, and for the past 15 years, foundation systems for single-family, multi-family, and light commercial structures built on expansive soils.

Since 2010, my concerns surrounding climate change have been increasing, and I've paid special attention to the common air pollutants produced by construction and demolition, such as Ozone, Nitrogen dioxide, Sulphur dioxide, and the most talked-about, Carbon dioxide, or CO2. In fact, it is this emission and its relationship to concrete in the construction of foundations that I'd like to confine my comments to, as the production and transport of concrete is the single biggest cause of CO2 emissions in the entire building process.

| Background: Where the Numbers Come From

The United Nations Framework Convention on Climate Change (UNFCCC), adopted at the 1992 Earth Summit, was one of the first international treaties on the topic. It stipulates that parties should meet regularly to address climate change at the Conference of Parties, or COP, and formed the basis of future climate agreements.

The Kyoto Protocol, adopted in 1997, was next, and regulated greenhouse gas reductions for a limited set of countries from 2008 to 2012, and was extended until 2020 with the Doha Amendment in 2012. It also laid the framework for the bottom-up approach of the Paris Agreement, which was ratified in 2015. Both were designed to address climate change, with the central aim to keep the global temperature rise below 2 degrees Celsius. The agreement encourages all countries to reduce emissions, or Nationally Determined Contributions (NDCs), something the USA embraced when it pledged to reduce its greenhouse gas emissions 50 to 52% below 2005 levels by 2030.

Overall, the information highlights efforts at different levels (domestic and international, local and state) to address greenhouse gas emissions and combat climate change. It demonstrates the commitment of various entities to act and reduce their carbon footprint,

contributing to global efforts to mitigate their impacts (for example, California has Assembly Bill 32, requiring the state's emissions be reduced 80% below 1990 level by 2050. Other states and countries have similar legislation in place or in progress).

| The biggest causes of CO2 in Construction

As previously mentioned, the production of concrete – and, particularly cement – is one of the biggest sources of CO2 emissions in construction. Portland cement production is a significant source of the emissions due to the chemical reactions involved in its manufacturing process. The primary greenhouse gas emitted during cement production is carbon dioxide (CO2), and according to US EPA AP-42, comes from two main sources:

- **The calcination of limestone.** Limestone (calcium carbonate – CaCO_3) is heated in a kiln at high temperatures to decompose the limestone into lime (calcium oxide – CaO), which releases CO2 as a byproduct. This calcination process is a major contributor to cement-related emissions.
- **The combustion of fossil fuels.** Energy is required to operate the cement kilns and other machinery in the production process. Typically, fossil fuels such as coal, natural gas, or oil are used to provide this energy. The combustion of these fossil fuels releases additional CO2 into the atmosphere.

These two sources alone combine to generate a range of 450 to 850 pounds, or approximately 0.22 to 0.42 tons, of CO2 emissions per cubic yard produced.

It's important to note there are ongoing efforts by groups both in and out of the cement industry to improve its environmental performance and reduce CO2 emissions. Some of the more high-profile projects include a \$2 billion investment by Bill Gates to develop low carbon cement, a MIT deep research undertaking into various aspects of better cement usage, and even the pursuit of carbon-free cement by venture backed Brimstone Energy in San Jose, CA. However, given the high demand for the product in the USA and the limitations of current production technologies, significant challenges remain in achieving substantial reductions by these actions in the near term.

| The Transportation of Concrete

The transportation of concrete to a job site using diesel fuel also results in the emission of CO2, with the exact amount depending on several factors such as the distance traveled, the type and efficiency of the transportation vehicles, and the specific characteristics of the diesel fuel used. However, and on average, diesel emits approximately 25 pounds of CO2 per gallon burned.

Combined together, this means the total CO2 emissions associated with the manufacture and transport of cement and concrete to a job site often ranges from 475 to 875 pounds (approximately 0.25 to 0.45 tons) of CO2 per cubic yard of concrete.

RPS Slabs: 20% Average Less CO2 Than Comparable Slabs

For more than a decade, I have monitored Geogrids and similar technologies that improve soil stabilization and provide a more sustainable foundation for buildings, again, especially when built on expansive soils. One in particular has leapt to the forefront in recent years, the RPS foundation-forming system.

An RPS slab is created by connecting a series of RPS void forms — 30" × 30" plastic forms* that come in various heights and are set directly on a levelled subgrade. After the steel reinforcing is installed (RPS slabs can utilize either rebar or post tension cables), a monolithically poured top slab, usually 4" thick, is then placed. No other footings are required. The monolithic pour creates concrete beams that run in both directions throughout the footprint. The completed mat sits on the ground like a raft, the void areas underneath the top slab formed by the placement of the boxes allowing for the movement of expansive soils.

The voids not only enhance the load-bearing capacity of the soil, they also enable a significant reduction in the amount of concrete used, which in turn substantially lowers CO2 emissions as less cubic yards of concrete are used and transported to the job site.

20% less

CONCRETE THAN A COMPARABLE UNIFORM-THICKNESS,
IN-GROUND RIBBED, OR SPREAD-FOOTING SLAB – ABOUT
5 TO 10 TONS LESS CO2 PER PROJECT

By one comparison, an RPS slab uses about 20% less concrete than a comparable uniform thickness, in-ground ribbed slab, and/or slab with spread footings. This translates to about 5 to 10 tons less CO2 when measured against the other foundation types.

Beyond the CO2 emissions, reductions in oxides of nitrogen, particulate matter, hydrocarbons, and carbon monoxide would also occur. These could be quantified as well, but would track and correlate to corresponding reductions in CO2.

Summary

Efforts to reduce the carbon footprint of concrete include using more sustainable cement alternatives, optimizing production processes, improving transportation logistics, and most importantly, adopting energy-efficient technologies that reduce the use of concrete.

The use of RPS in foundation construction leads to significant reductions in the amount of concrete needed for foundations on expansive soils, often ranging from 10% to 20% less than alternative slabs depending on the project. This reduction in usage results in a corresponding, substantial, decrease in CO2 emissions, and an overall more sustainable and environmentally friendly approach to foundation construction.

References

Paris Accords UNFCCC, October 2019

United States EPA AP-42, January 1995

*RPS void forms are made of recycled polypropylene plastic, itself a very 'green' material.

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About the Author

Mel Kimsey graduated from the United States Military Academy at West Point in 1972 with a BS in Engineering, and received his MBA from Pepperdine's Graziadio School of Business in 1982. He has worked with technology companies for over 45 years, including for 24 years owning and running a manufacturing company in this sector. He remains an active advisor and angel investor in several dozen technology companies today.

This paper is presented for informational purposes to developers, engineers, and contractors by RPS, providers of the RPS foundation forming system. An RPS slab is a 5th generation on-grade slab designed and engineered specifically for expansive, compressible, or rocky soils. It delivers superior performance and significant cost savings — especially when compared to in-ground ribbed and/or uniform thickness foundations.

CONTACT

For more information on RPS foundations go to www.rps-usa.com or call **Brian Cudd** at **(281) 923-6862**.