INDUSTRY REPORT

REDUCING CARBON EMISSIONS BY SWITCHING TO A HELICAL PIER FOUNDATION

The pressure is on for the construction industry to slash CO2 emissions. Helical piers could be your answer to dramatically reducing the carbon emissions of your project. See how helical piers and concrete compare in this in-depth report on the carbon impact of steel and concrete

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Forward

If you're building projects in renewable energy, oil & gas, or transmission and distribution, you have a lot to think about. Timelines, budgets, materials, equipment, permits, inspections, and on it goes. There's plenty to keep busy with when planning a new project or expansion to existing infrastructure.

There's another aspect you have to closely consider as well: the environmental impact of your project.

Politicians, investors, the media, and the public, are all looking to the construction industry to make an even greater effort to reduce the carbon emissions of our projects. Here's the tough reality people outside the industry don't realize... reducing CO2 emissions isn't easy.
Balancing cost, speed, and carbon emissions, is a tall order when we're talking about industrial construction.

Most of the emissions a construction project generates are caused by the raw materials used. Producing steel, concrete, and plastics, releases CO2 into the atmosphere. It then stands to reason that one of the fastest ways to reduce the carbon footprint of your project is to use less raw material.

But, can helical piers actually *reduce* your project's overall CO2 emissions?

After all, helical piers are made from steel which is responsible for up to 9% of global CO2 emissions (World Steel Association, 2022). Concrete is responsible for 8% of global CO2 emissions, making it a close second to the steel industry (Ramsden, 2020).

How can helical piers have a *lower* CO2 impact than concrete when both raw materials have similar *overall* carbon emissions?

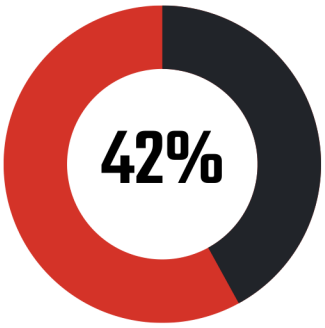
Let's answer the big question: **Can a helical pier foundation help you reduce the overall CO2 emissions of your construction project?**

John Lisle

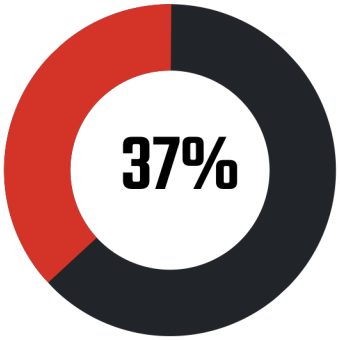
Co-Founder at S&B Helical

Why Care About CO2 Emissions?

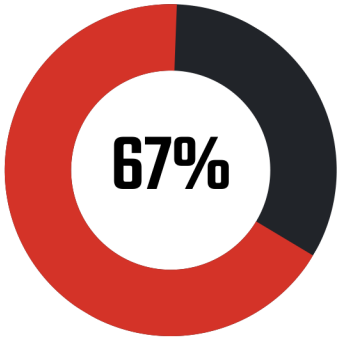
There's many opinions (and arguments) regarding the CO2 emissions our construction process produces. This report will not debate the extent to which humans can affect the environment. Regardless of the specifics it's clear the industry is expected to do more to reduce emissions in your construction projects. This issue affects the decisions you make for every facet of your project - from materials down to construction methods.



Americans who favor emissions reduction as climate change strategy
(Rabe & Borick, 2022)



Building sector emits 37% of global annual GHG emissions
(UN Environment Programme, 2022)



Americans prefer mix of fossil fuels & renewables
(Tyson et al., 2022)

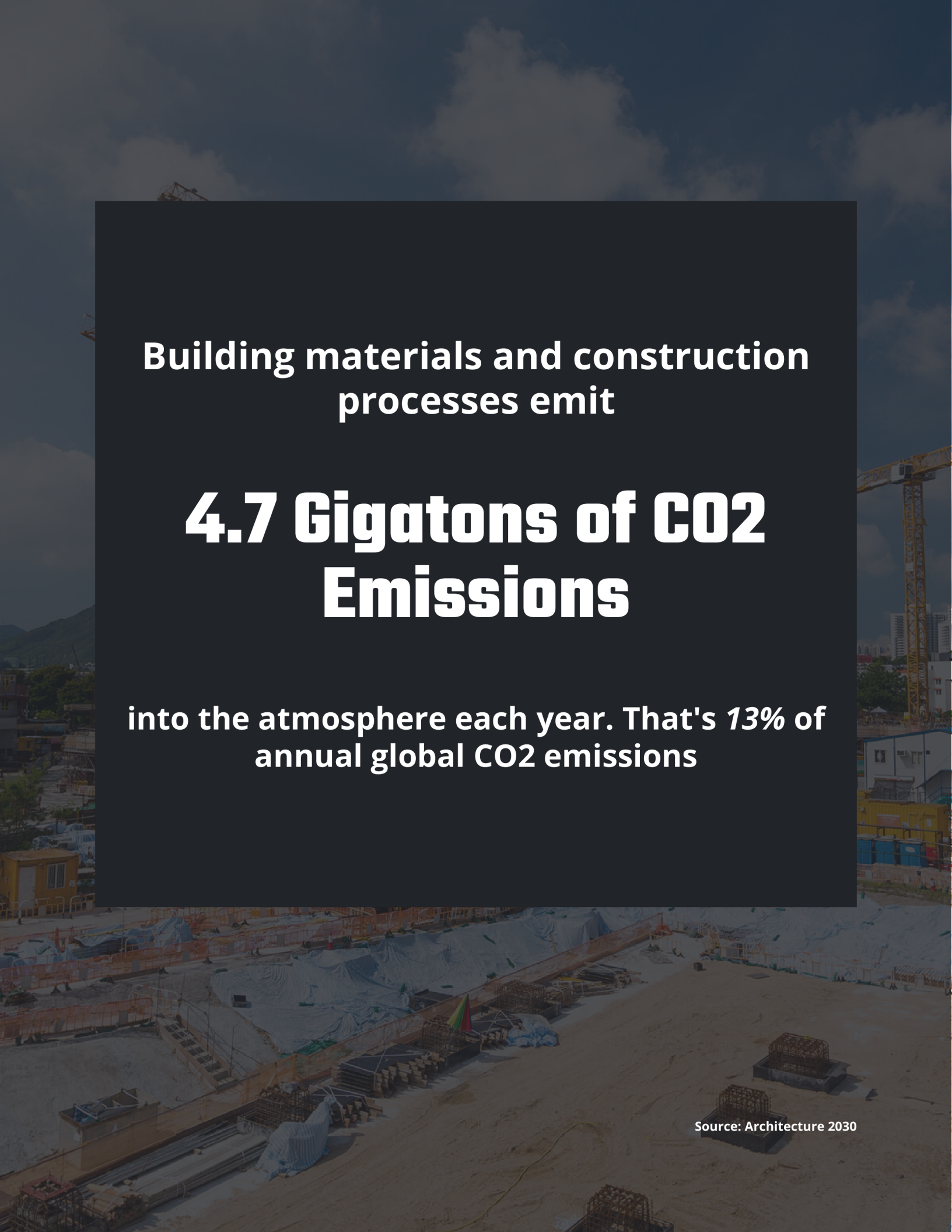
The Complexity of Calculating CO2 Emissions

Calculating the CO2 emissions related to a construction project is a complex question.

Everything from raw materials to how many personnel and equipment are on-site will impact your emissions.

This report is focused on comparing the **overall carbon (CO2)** emissions cost of the raw materials it takes to manufacture a helical pier foundation versus poured concrete.

To avoid getting stuck in the details, we aren't factoring emissions from equipment or other sources but it is important to outline some of the variables that can affect the CO2 emissions associated with your foundation.



Building materials and construction processes emit

4.7 Gigatons of CO2 Emissions

into the atmosphere each year. That's *13%* of annual global CO2 emissions

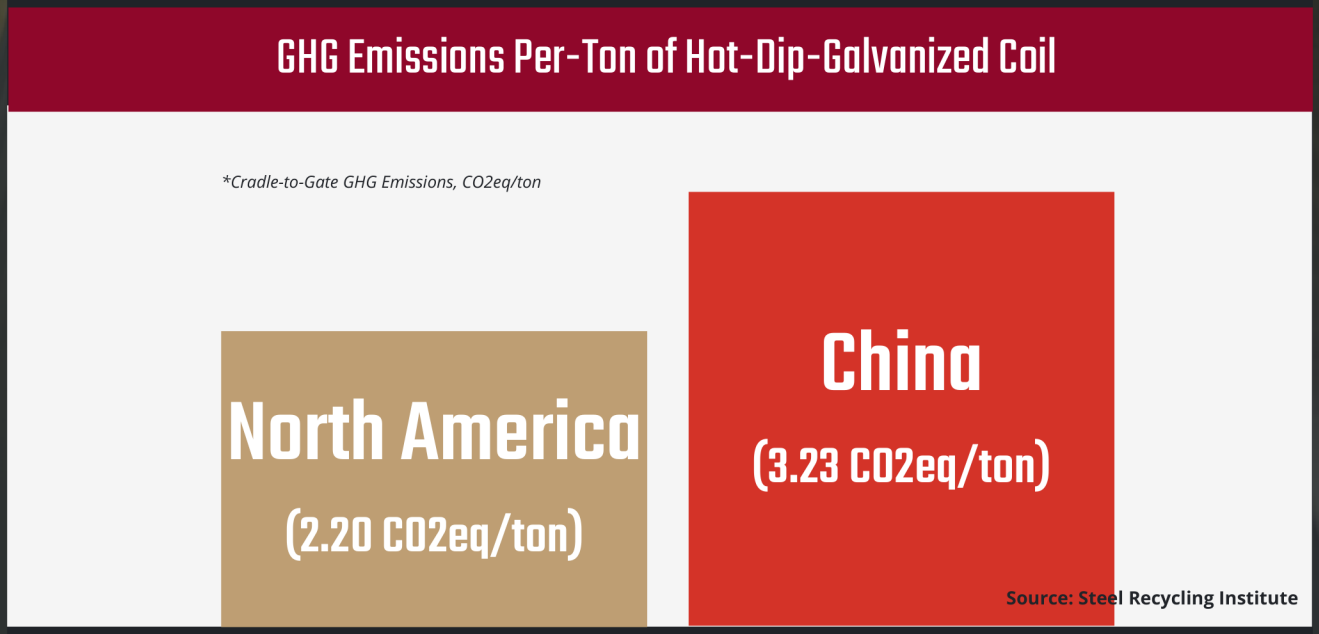
Source: Architecture 2030

What Factors Affect CO2 Emissions in Raw Materials?

The lifecycle of steel and concrete material is complex and can span the globe. This makes calculating the precise CO2 emissions of any one raw material a particularly challenging task. While there are established CO2 emissions figures for steel and concrete, it's equally true there's also factors that impact those figures. Here's some of those factors:

Where was the raw material produced?

Different countries have different environmental laws surrounding the production of steel and concrete. China, for example, has much looser regulations on pollution so steel produced there tends to have higher carbon emissions than domestic steel. One study found that Hot Dip Galvanized (HDG) steel produced in China emitted 50% more greenhouse gas compared to North American HDG steel.



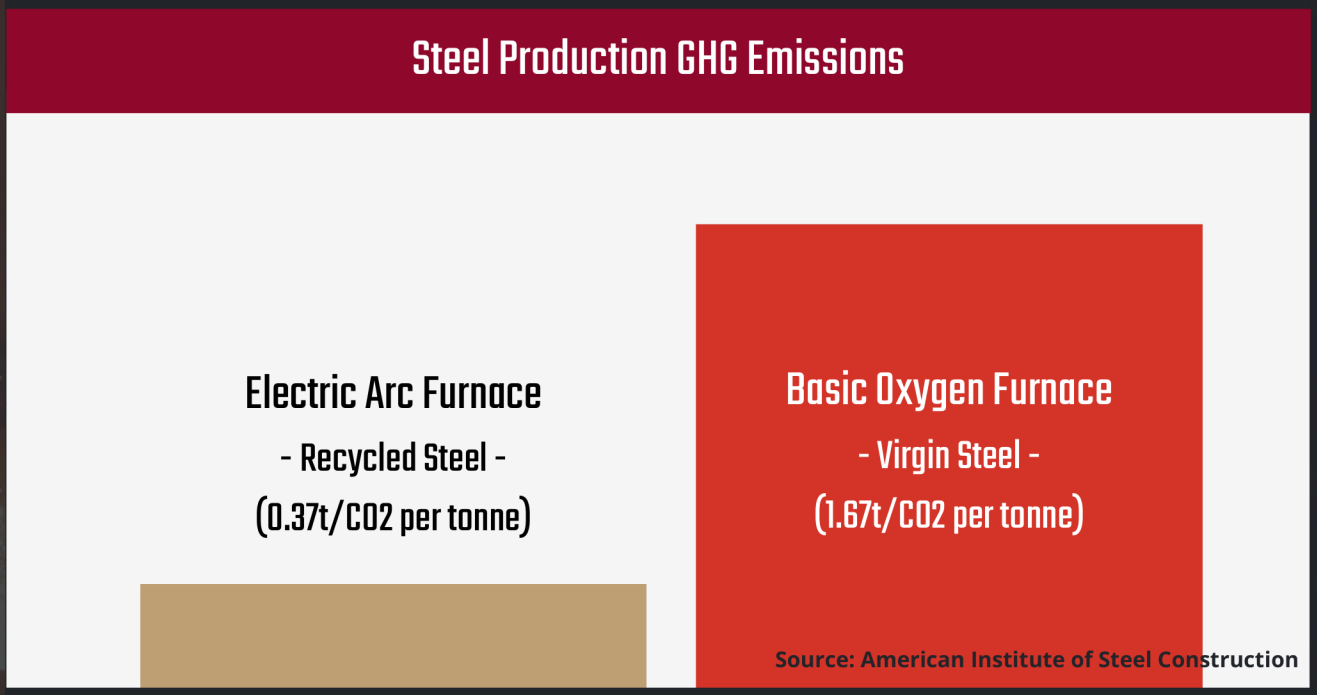
American-produced steel, on the other hand, tends to be comprised of recycled steel which produces lower CO2 emissions.

According to the American Institute of Steel Construction, American steel mills recycle over 70 million tonnes of scrap each year.

How was the raw material produced?

Steel can be produced in a blast furnace-basic oxygen furnace (BF-BOF) or in an electric arc furnace (EAF).

A BF-BOF melts down iron ore to create steel material, a process that produces huge amounts of CO2 emissions.



An EAF, on the other hand, takes recycled scrap and transforms it back into useful steel, which requires fewer emissions.

EAF's can also be run using renewable energy which cuts their emissions even further.

How far did the raw material travel?

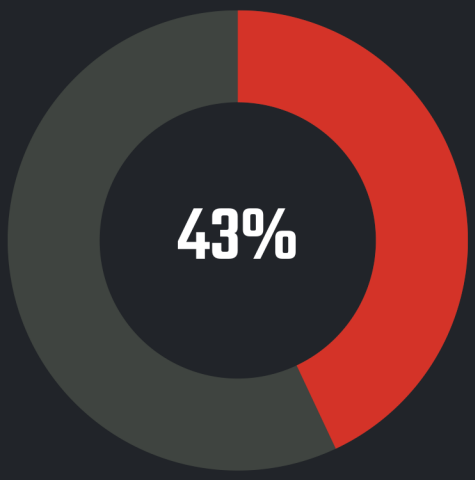
Some helical pier manufacturers in the U.S.A. use steel from China to build their piers, while others source materials from North America.

Transporting hundreds of tonnes of steel thousands of miles across the ocean will increase the overall CO2 impact of that steel compared to steel produced in North America.

Cement is no different.

The Mineral Commodity Summary for Cement for 2022, published by the National Minerals Information Center at the USGS, stated that domestic U.S. cement production was slowed by inexpensive cement imports - and at least **43% of cement imports** were from overseas.

By sourcing raw materials in North America or the United States, the carbon impact of a steel or concrete foundation can be reduced.

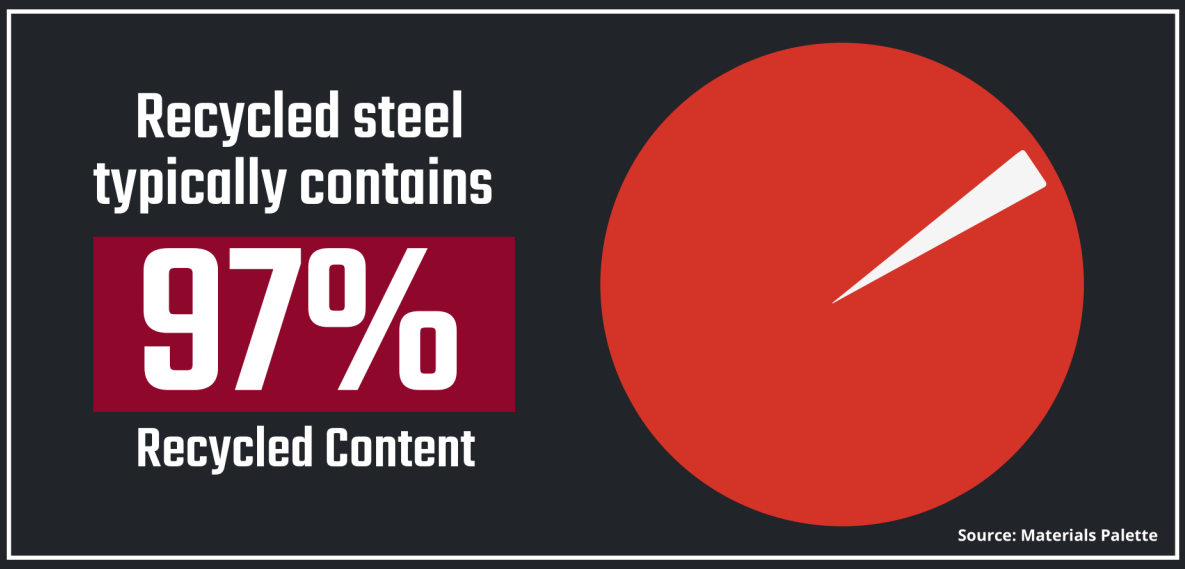


According to the National Minerals Information Center, from 2017 to 2020, 43% of cement imported into the U.S.A came from sources overseas.

Source: U.S. Geological Survey

Are recycled raw materials being used to manufacture the foundation?

According to Materials Palette, recycled steel typically contains as much as **97% recycled content** overall. Steel can also be recycled infinitely without losing any of its integrity or structural properties (World Steel Association, 2022).



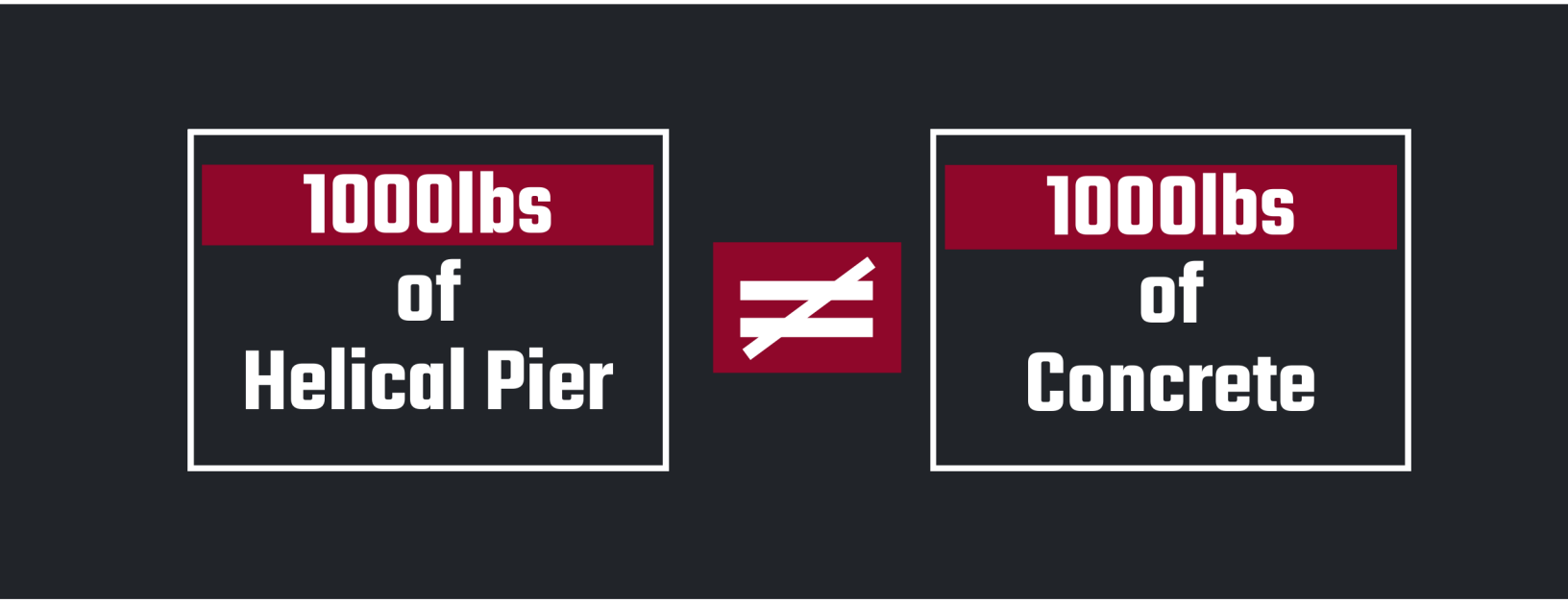
Concrete can be reused or down-cycled, but it's not a true recyclable material. You can't crush concrete and turn it back into a functional mix. It can be reused as aggregate but still needs cement and other materials mixed back in (Souza, 2022).

It's still a good idea to re-purpose concrete waste, but it shouldn't be considered "recyclable".

Carbon Emissions Per-Tonne for Helical Piers Vs. Concrete Foundations

Helical piers are, by nature, more efficient in their design than a typical poured concrete foundation. That's not to say concrete can't be well-engineered or that it can't be efficient, because it certainly can be. Overall, however, helical piers demand less raw material, equipment, and time, to manufacture and install.

This means that helical piers are able to replace hundreds of tonnes of concrete and still achieve the same, if not even better, support.



The amount of raw material required for your foundation will have the largest impact on the overall CO2 footprint that foundation produces. One of the ways to lower the carbon emissions of your project, then, is to reduce the amount of raw material you use for your foundation.

The best way to demonstrate the reduction in carbon emissions that can come with switching from a poured concrete solution to helical piles is to compare the CO2 emissions of the two technologies.

To do this, a helical pier foundation will be measured against the comparable poured concrete alternative to measure any differences in CO2 emissions between the technologies.

Helical Pier Foundation

As seen earlier, there's several factors that affect the carbon footprint of steel. The Steel Manufacturers Association published an independent report that aimed to calculate CO2 emissions for steel manufacturing in the United States.

This report uses the figures published by the Steel Manufacturers Association to calculate the CO2 emissions of steel.

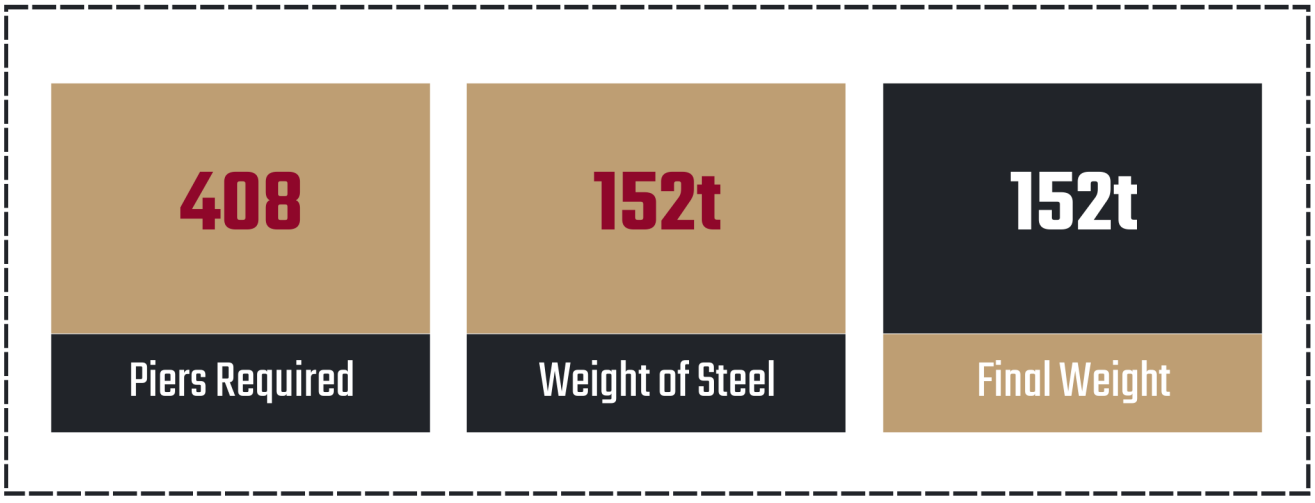
Their report indicated that "virgin steel", new steel that's created using a Blast Oxygen Furnace (BOF), releases an average of **1.67t/CO2 per 1t of steel** produced.

Recycled steel that's produced in an Electric Arc Furnace is much more efficient and only produces **0.37t/CO2 per 1t of steel** produced.

Here in the U.S. almost **70%** of all our domestically produced steel is recycled steel (Steel Manufacturers Association, 2022).

That makes it challenging to know whether to use 1.67t/CO2, 0.37t/CO2, or something in-between, when calculating the carbon emissions of the raw steel material.

We calculate the CO2 emissions of steel using a "worst case scenario" of 1.67t/CO2. Your CO2 numbers will vary depending on how your steel is produced.



CO2 Emissions for a Helical Pier Foundation

The helical pier foundation in this example requires **152 tonnes of raw steel** material to manufacture the foundation.

In order to find the CO2 emissions of the **raw steel material**, the tonnage of steel required can be multiplied by the CO2 emissions per-tonne of steel **(1.67t/CO12).**

This makes the equation:

152t * 1.67t/CO2 = 254t/CO2 total emissions

152t*1.67t/CO2 =

254t/CO2 Total Emissions

In order to produce the raw materials needed to manufacture the entire helical pier foundation for this project, it's going to output **254 tonnes of CO2** into the atmosphere.

Again, this only assesses the CO2 impact of the raw steel material. It's not calculating the potential carbon emissions of transportation or installation. However, it does provide an idea of the rough amounts of emissions that could be expected from a helical pier foundation in this configuration.

To understand how these emissions figures compare to concrete, we must calculate the potential impact of the raw materials required for a poured concrete foundation.

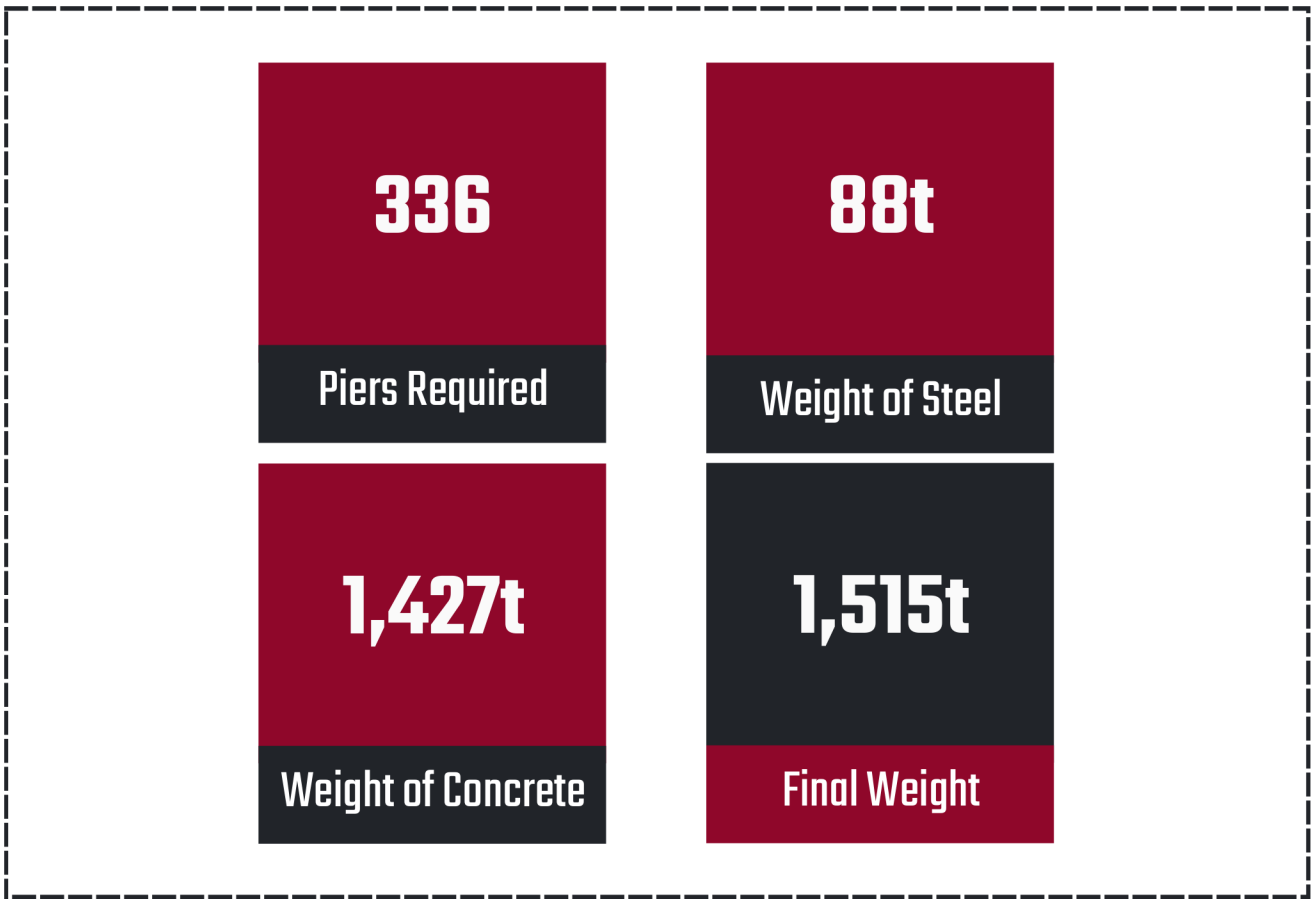
Poured Concrete Foundation

A poured concrete foundation is comprised of two main components: **steel rebar** reinforcement and the **concrete** itself.

Steel rebar is a crucial component of a concrete foundation as it adds additional strength to the poured concrete. This means calculating the carbon emissions emitted by the raw material needed for a poured concrete foundation requires two steps.

First, we will measure the carbon impact of the raw steel required to manufacture the rebar used for reinforcing the concrete.

Second, we will use industry figures to assess the carbon emissions for the raw materials needed to create the concrete used in the foundation.



CO2 Emissions for a Concrete Foundation

Steel Rebar Calculation

The CO2 emissions of the steel rebar will be calculated using the same **1.67t/CO2 per 1t of steel** figure as above. While recycled steel will have a lower environmental impact, we'll use "worst case" emissions figures for the sake of simplicity.

This foundation requires 87t of steel rebar to reinforce the concrete, which makes the equation for this calculation:

87t * 1.67t/CO2 = 147t/CO2 steel rebar emissions

87t*1.67t/CO2 =

147t/CO2 Steel Rebar Emissions

To produce the raw material required for the steel rebar, it could output **147t/CO2** into the atmosphere.

Because there's less steel material required for the concrete foundations, the emissions from steel are **lower** for the concrete foundation in this example. However, we must calculate the emissions from the raw concrete material before we can assess the true differences between these two foundation solutions.

CO2 Emissions for a Concrete Foundation

Concrete Calculation

One of the key ingredients of concrete is cement, and it's cement that's responsible for the majority of emissions when it comes to concrete production (Andrew, 2019). Other materials, like quarried or recycled aggregate, contribute very little to emissions compared to cement.

The IEA calculates that **0.5t/CO2 to 0.6t/CO2** are produced **per 1t of concrete** (IEA, 2022). Other sources indicate between **0.6t/CO2 to 0.7t/CO2 per 1t of concrete** (WBCSD, 2016).

In order to maintain the "worst case scenario" calculation, we will use the emissions figure of **0.7t/CO2 per 1t of raw concrete material.** This foundation configuration requires **1,427t of concrete**, which makes the emissions calculation:

1427t*0.7t/CO2 =

999t/CO2 Concrete Emissions

To find the **total CO2 cost** of the raw materials needed for a concrete foundation, we add the rebar and concrete together:

Rebar
147t/CO2

+

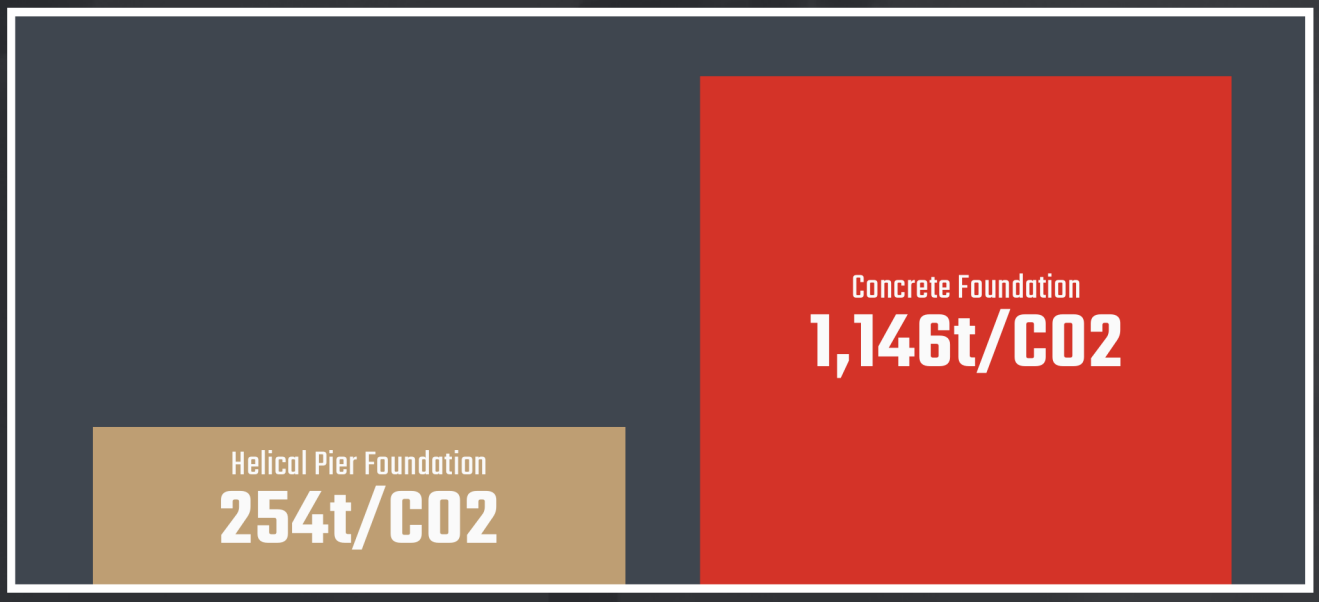
Concrete
999t/CO2

=

Total CO2 Emissions
1146t/CO2

Comparing Helical Pier & Concrete Emissions

In this example, a concrete foundation solution would output **351% more CO2 emissions** compared to helical piers. But, CO2 emissions aren't the only consideration when it comes to assessing the environmental impact of your foundation.



The helical pile foundation in this example would use **163% less raw material** than a comparable concrete solution. That means less raw material removed from the earth, less processing required for those materials, and less weight to transport.

Here's another way to consider these results.

By using helical piles instead of concrete for our example foundation, it would save the CO2-equivalent of taking **194 passenger vehicles** off the road for an entire year.

These calculations were also completed using "worst case scenario" figures for the emissions. In reality, your emissions could be less (or more) based on a variety of factors.

The numbers presented here are not meant to be taken as fact, instead they are illustrating the potential differences between the CO2 emissions of helical pier and poured concrete foundations.

Conclusion

The scrutiny regarding carbon emissions and construction activities will not go away. If anything, this attention will only become more focused and intense in the coming years.

While the emissions figures presented for helical pier and concrete foundations may not be 100% precise, they do give a more clear picture of the gap between the two solutions.

Because a poured concrete foundation requires significantly more raw material than a comparable helical pier design. the overall CO2 emissions for the raw materials will be dramatically increased. Indeed, that's what the calculations indicate.

However, it's important to highlight that while the math indicates a helical pier foundation will output less carbon overall, that doesn't mean it's better than concrete in every scenario. Emissions are a critical factor to consider when assessing foundation options, but they are not the only factor. Ultimately, which foundation is right for your project depends on the unique demands and needs of that project.

At the end of the day, what does this report mean for your projects?

First, it means that if you have not considered a helical pier solution you could be missing out on a highly efficient and environmentally-friendly foundation technology.

Second, you can't make a final decision on your foundation based on a single report. You need a complete evaluation of your different options and what the potential benefits or downsides might be.

In both cases, the best thing you can do is get in touch with a foundation expert that can help you assess those different options and help you identify which is best.

In the end, making a meaningful difference to the greenhouse gas emissions associated with construction activities will take more work than simply choosing one foundation or the other. But, by understanding your options and how they affect your CO2 output, you can make a more informed decision about your foundation.

Not only does it make better sense for your project, but it makes better sense for your community and the future of the planet.

Questions or comments about this report?

Let our team of foundation experts answer your questions about **faster**, **easier**, more **efficient**, and more **environmentally-friendly** foundations.

Get In Touch

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