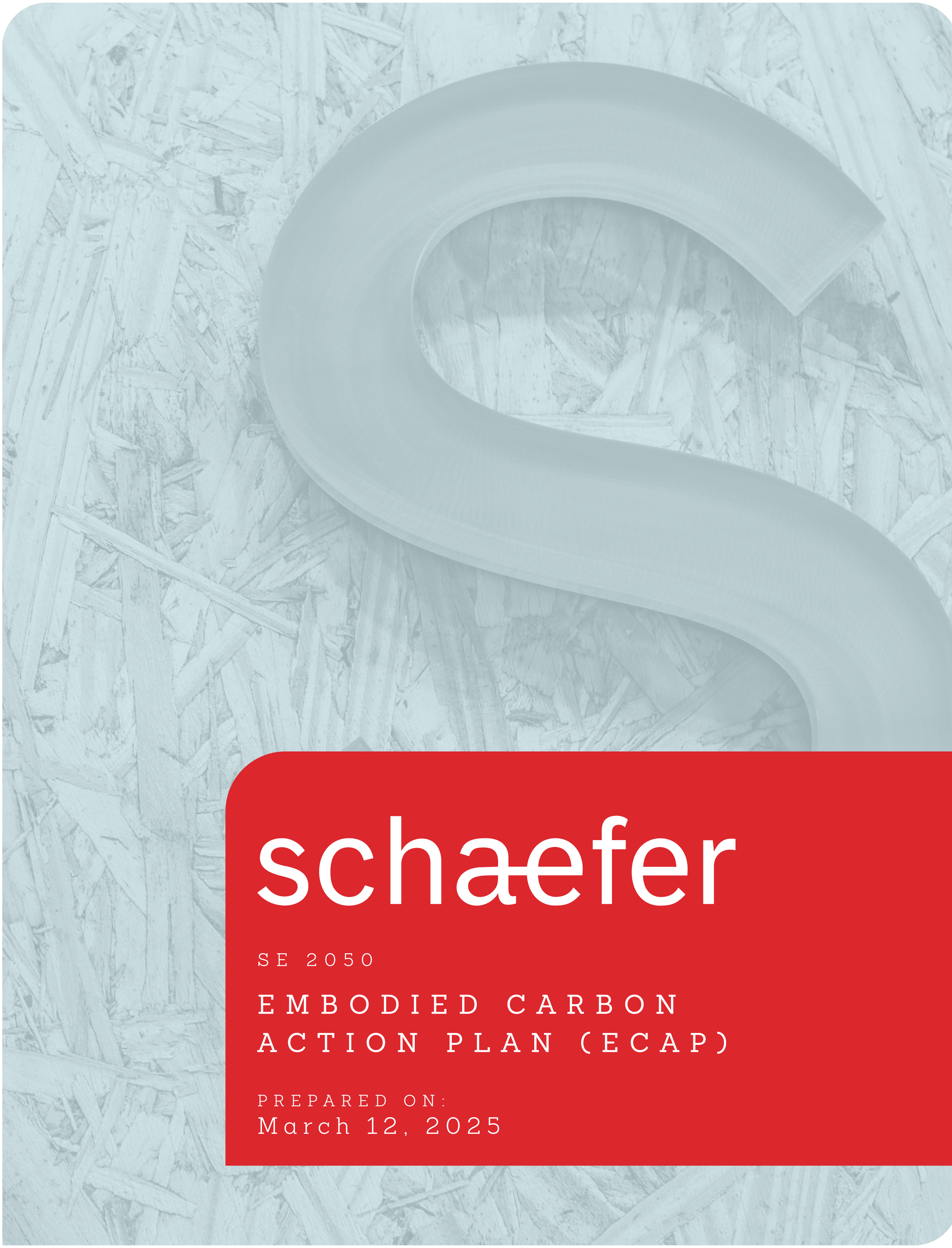


schaefer

SE 2050

EMBODIED CARBON ACTION PLAN (ECAP)

PREPARED ON:
March 12, 2025

hi.
we're Schaefer's sustainability team.

lara stroup, PE, LEED AP BD+C
PROJECT MANAGER

With post-graduate degrees in both structural engineering + architecture, Lara has a unique perspective when it comes to marrying necessary structural elements + desired facility aesthetics. Lara has 14 years of industry experience and has spent about half of her career at Schaefer. She works on diverse projects with differing size, geography + purpose. Lara is passionate about sustainability and making an impact on the world around her, and began leading Schaefer's sustainability initiative in 2021. As initiative champion, she's contributed thought leadership + provides resources to those designing according to sustainability goals and/or interested in expanding their knowledge in the area. Lara is a member of the National Council of Structural Engineers Association's (NCSEA) Sustainable Design Committee and founded the Structural Engineers Association of Ohio (SEAoO) Sustainable Design Committee.

aaron pajestka
PROJECT ENGINEER

columbus office

focus: research + development of sustainable steel strategies

peter householter
DESIGN ENGINEER

cincinnati office

focus: documentation + approaches to sustainable wood design

john thesing
PROJECT ENGINEER

cincinnati office

focus: embodied carbon calculations + reporting

education

how we're leading the field.

internal inclusion

It's important that everyone has the opportunity + access to be involved in our sustainability initiative. Our sustainability team stretches across our firm's geography with team members present at two of our three offices. The sustainability team is available for advice on how to address sustainability concerns.

We regularly shine a light on our efforts by providing updates + educational opportunities at firm-wide staff meetings. In addition, we post articles + SMART sheets to our firm knowledge management tool, ranging in content + knowledge level from a glossary of sustainability terms to an article from a structural magazine to a short video on life cycle analysis.

SMART conference

2022-2024

Each year, Schaefer hosts a conference for all team members to engage in an educational, social + collaborative two-day experience. Since 2022, our sustainability initiative team has hosted an educational session during the conference with both internal + external speakers, and both presentation + hands-on approaches. Topics that we've covered include:

> Types of sustainability certifications
> Measurements of a building's sustainability
> New technologies
> Ways we can implement sustainability into our everyday lives




education

SMART conference *continued*

- Life cycle assessments
- Environmental product declarations (EPDs)
- Embodied carbon basics + how it relates to the A/E/C industry
- Whole building life-cycle assessments
- Environmental Product Declarations (EPDs)
- Strategies for reducing embodied carbon on projects

2025 + BEYOND

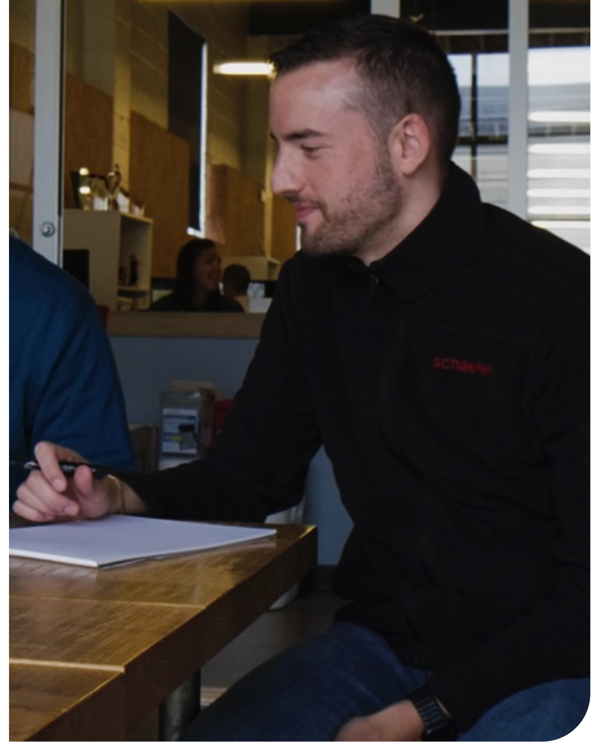
As we welcome new engineers to our firm, SE 2050 + embodied carbon training will be included in our onboarding process. New team members will learn:

- Schaefer's commitment to SE 2050
- What embodied carbon is + how it relates to the A/E/C industry
- What resources are available to them

education

how we advocate.

knowledge sharing initiative



We met with some of our clients that have expressed sustainability goals to discuss potential collaboration in the years to come. Our clients told us that they want:

- Earlier collaboration on sustainability goals
- Innovative solutions
- Assistance on embodied carbon calculations and life cycle assessments (a service we're developing)

We share content on our firm blog to connect with our clients on our SE 2050 initiative and share what it could mean for them. We provide the tools to our team so they can start the discussion on embodied carbon goals with our clients on each project. It's important to our team that our clients know they are our priority, and we will work with them on their goals.

We believe in knowledge sharing amongst other structural engineers as well. Our initiative champion, Lara, is a member of the National Council of Structural Engineers Association's (NCSEA) Sustainable Design Committee and founded the Structural Engineers Association of Ohio (SEAoO) Sustainable Design Committee. Schaefer team members have presented on the topic of embodied carbon at multiple events including:

- **Structural Engineers Association of Ohio | annual conference**
  "Sustainability in the Built Environment: Why Should I Care?"
  Schaefer presenter | Lara Stroup, project manager
  Co-presenter | Ebiji Akah
  September 12, 2024

education

> **Design Columbus**
"The Bigger Picture: Case Study of Cincinnati Public Radio Mass Timber Project"
Schaefer presenter | Doug Steimle, operations leader | principal + Lara Stroup, project manager
Co-presenter | emersion DESIGN
March 11, 2024

> **REBUILD**
"The Bigger Picture: Case Study of Cincinnati Public Radio Mass Timber Project"
Schaefer presenter | Doug Steimle, operations leader | principal
Co-presenter | emersion DESIGN
October 12, 2023

strategy

let's get to work.

one-year reduction strategy

We're starting with high benefit/low energy solutions; we feel it's important to make our solutions practical.

> Some existing technologies can be applied to a project simply by discussing with the client + changing the specifications. Ideas like this will build early confidence internally and start conversations with our clients.

> We'll start to include alternative, sustainable choices in our general notes. We'll provide guidance for the master specifications and how to specify low embodied carbon materials.

> We'll perform an embodied carbon study on six projects, building on the five from 2024. By creating a library of past projects, we'll have data to support our clients + provide recommendations on the best choices for their specific projects.

five-year reduction strategy

Over a five-year period, our sustainability team hopes to impact multiple aspects of our firm, from the work we do to our own offices.

> The work depends largely on our clients and aligning with their goals. We'll develop + implement a workflow that helps our team communicate embodied carbon impacts of different design options to our clients.

> Our team will perform embodied carbon studies on at least five projects every year. Our goal will be to increase the number of projects per year to ten by 2030. Projects will be chosen from diverse markets, materials + locations to maximize our inclusion + create comprehensive data.

> We'll complete embodied carbon calculations at three times: early design, end of design + during construction. This will help us track how changes made to the project impacted the overall embodied carbon.

how we'll continuously improve.

life cycle assessment tools + reporting

Over the last two years, we have investigated multiple life cycle assessment tools – we decided TallyCAT and EC3 were best for our workflow in 2023 + 2024. At the end of 2024, we purchased a license for Tally to include additional stages in our life cycle assessments. Moving forward:

> We'll complete life cycle analyses for stages A1-A4 , C2-C4 + D. Our plan is to use the industry average data preset in Tally.

> We'll prioritize calling manufacturers for EPDs when unknown. When unavailable, we'll utilize industry + regional data.

> We'll complete an embodied carbon calculation at the end of the design phase and before the construction administration phase. To determine quantities, we'll utilize Revit, a tool we use to model most projects. This will easily show quantities, but in some project types, it will require a higher level of detailing than we normally draft.

lessons learned

> Mass timber is a sustainable option from many regards, but performs poorly in a whole building LCA when it comes to emissions outside of embodied carbon due to its lack of end-of-life reuse (assumed in many life cycle assessment models). As engineers, we need to consider all aspects of the building + choose the material that is right for the project. There is no one-size-fits-all solution.

> TallyCAT and EC3 are great tools to calculate the embodied carbon on our projects and integrate well with Revit. However, the tools are limited to the A1-A3 stages which does not allow us to perform a WBLCA (which our clients are looking for).

> Tally has its limits as a life cycle assessment tool. While it integrates well with Revit making the calculations easy, there is limited ability to adjust the EPDs or material specific emissions.

> Making embodied carbon reductions takes effort from all design team members, from the architect to the contractor to the material suppliers.

appendix

firm profile

view our work at **schaefer**-inc.com

schaefer

We are open-minded in our approach + thinking — thought leaders with diverse experience.

Our clients partner with us for our collaborative structural engineering services: planning, design, inspection, investigation.

- 100+ team members
- Licensed in EVERY state
- 15+ years into full implementation of BIM
- Founded in 1976, offices in Cincinnati + Columbus, Ohio, and Phoenix, Arizona

We believe in collaborative teams — partnership with owners, architects, developers + construction team members.

With a creative approach supported by an understanding of market trends, we can design adaptive structures that meet owners' needs. Our people enhance communities through smart, innovative structures.

CINCINNATI OFFICE

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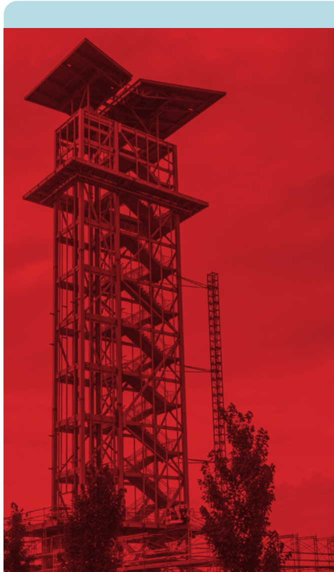

March 6, 2023

schaefer CONNECT

Laura Champion
Structural Engineering Institute

Re: Letter of Commitment to the SE 2050 Program

GREETINGS!

Schaefer, a 96 person firm located in Cincinnati, OH; Columbus, OH; and Phoenix, AZ, is hereby signing on to the SE 2050 Commitment Program. We support the vision that all structural engineers shall understand, reduce, and ultimately eliminate embodied carbon in their projects by 2050.

At Schaefer, we are committed to deliver sustainable design to enhance our communities of today + tomorrow. As part of our vision to Lead the Field, we believe we need to look for ways to reduce the embodied carbon in our structural designs.

Therefore, we commit Schaefer to take the following steps as a part of the SE 2050 Commitment Program:

> Within six months and annually going forward, we commit to reporting an Embodied Carbon Action Plan (ECAP). We permit the ECAP document be made public on the SE 2050 website.

> Within one year and annually going forward, we commit to submit data to the SE 2050 project database in a collaborative effort to understand embodied carbon in structural engineering projects and to set attainable targets for future projects.

We look forward to joining this coalition and industry effort to achieve the goals of the SE 2050 Program.

Sincerely,

Gregory A. Riley

Greg Riley, PE

President

schaefer-inc.com
537 East Pete Rose Way, Suite 400
Cincinnati, Ohio 45202
800.542.3302

internal announcement

Schaefer joins SE 2050 commitment program

On March 6, 2023, Schaefer submitted its commitment letter to join in Structural Engineers 2050 Commitment Program (SE 2050).

What is SE 2050 Commitment?

SE 2050 is a program focused on minimizing (+ eventually reaching net zero) embodied carbon in structures by collaborating with the people who design them: structural engineers. The program was developed by American Society of Civil Engineers (ASCE) Structural Engineers Institute (SEI) Sustainability Committee with the goal of net zero embodied carbon structural systems by 2050.

What is embodied carbon?

Embodied carbon is the sum of greenhouse gas emissions associated with the manufacture + use of a product or service. You may see this measured by the unit global warming potential (GWP). All structures have embodied carbon that is created through their construction, maintenance + demolition.

How do we reduce embodied carbon?

There isn't one easy way to reduce embodied carbon. Here are a few techniques.

- Deliver efficient designs (over-designed projects often use more material). This is already part of Schaefer's culture and can be a win-win for the team – less material can lower overall construction cost.
- Design with lower carbon materials.
- Use recycled materials and/or reuse materials.
- Renovate existing facilities vs. building new.
- Use biomimicry – design to mimic efficient structures in nature.

Why is Schaefer joining the SE 2050 Commitment?

SE 2050 aligns with Schaefer's sustainability initiative to deliver sustainable design enhancing communities of today + tomorrow. Embodied carbon emissions affect the health of our communities. The architecture/engineering/construction industry, and we as structural engineers, can make a difference.

internal announcement

- Our industry contributes to roughly 30% of all global carbon emissions.
- Structural material production contributes to 10+% of global carbon emissions.
- 50+% of the embodied carbon in a building comes from the structure.

As structural engineers, we can make an impact on the triple bottom line of sustainability: economic, social + environmental.

What will Schaefer do next (as part of SE 2050 Commitment)?

We'll submit structural embodied carbon data from several of our projects. This information, collected from structural engineering signatories across the country, will give data points for the industry to analyze + determine impacts + trends with the ultimate goal to find opportunities to reduce embodied carbon.

We'll also complete an embodied carbon action plan (ECAP) that will be published on the SE 2050 Commitment's website (we'll post it on our site in September 2023). The ECAP will outline:

- Our efforts for firmwide embodied carbon education + reduction strategies
- How we'll report our projects' embodied carbon emissions
- How we'll advocate for sustainability + SE 2050 within our industry

We're committed to learning + leading sustainable design through innovative + accessible strategies + client collaboration. By championing sustainability in our projects + business practices, we can educate our communities on designs that meet the demands of today, while being conscious of the demands of the future.

blog post

greenhouse gas + structural engineering | how life cycle assessments can change the built environment

Nearly 40% of global greenhouse gas emissions are due to the construction + use of buildings, and nearly 50% of construction emissions are attributed to the structure itself. As the world recognizes the impact of carbon emissions on our climate, and ultimately the health + wellbeing of our communities, we're more aware of the need for change. But how? Let's start with how we measure a building's environmental impact using whole building life cycle assessments or embodied carbon calculations.

Whole building life cycle assessment

A whole building life cycle assessment (WBLCA) considers stages A1 through C4 or D. This type of life cycle assessment could be referred to as "cradle to grave" or "cradle to cradle." It measures embodied + operational carbon throughout the life of a building.

A1-A3 PRODUCT STAGE	A4-A5 CONSTRUCTION STAGE	B1-B7 USE STAGE	C1-C4 END-OF-LIFE STAGE	D BENEFITS + LOADS BEYOND THE BUILDING LIFE CYCLE
A1 raw material supply	A4 transport	B1 use	C1 deconstruction/ demolition	D reuse/recovery/ recycle
A2 transport	A5 construction installation process	B2 maintenance	C2 transport	
A3 manufacturing		B3 repair	C3 waste processing	
		B4 replacement	C4 disposal	
		B5 refurbishment		
		B6-B7 operational use		

blog post

A WBLCA can inform the design team where we can reduce carbon emissions and help make decisions throughout the design process. In addition, it helps us understand holistic carbon emissions related to various building systems and trade-offs between embodied + operational carbon.

(Did you know that LEED certification now awards points for performing a WBLCA and for showing emission reduction from a baseline project?)

When to perform a whole building life cycle assessment

WBLCA should be performed at various stages of a project starting in schematic design and during construction to verify initial assumptions. WBLCA should be used when a project wants to consider more than just upfront embodied carbon. This is especially important for projects with net zero carbon goals.

Who leads a whole building life cycle assessment

It's generally led by a sustainability consultant or the architect depending on their services.

Pros

- There's a plethora of free + paid subscription-based tools on the market to choose from. Many of these tools can work with Revit or other software used daily. The software is continuing to evolve and will only get better in the future.
- It can inform decisions early in the design process.
- It helps to understand holistic carbon emissions related to various building systems and the trade-offs between embodied + operational carbon.

Cons

- One of the biggest challenges is getting accurate data and addressing uncertainties in the future/end of life stage for the building.
- There are a lot of variables to consider which can lead to incompatibility of baseline comparisons. For example, in WBLCA, the main emission we measure is carbon dioxide. However, the types of emissions to evaluate should be based on your overall sustainability goals. Check that the same types of emissions are being evaluated across all material types used in the building for an apples-to-apples comparison.
- We continue to learn more about the impact of our industry on our planet. Guidelines continue to evolve based on new research and as we identify appropriate comparison values.

blog post

Whole building life cycle analysis can be an involved process and might not be right for you or your project. Luckily, it's not the only option.

Embodied carbon calculation

An embodied carbon calculation is the sum of carbon emissions for each material focusing on stages A1-A3. This is often referred to as "cradle to gate" phase. It only measures upfront embodied carbon.

As part of our SE 2050 Commitment, we're providing embodied carbon calculations on several of our structures.

When to perform an embodied carbon calculation

Embodied carbon calculations can be done at any stage in design or construction; it's helpful when it happens at multiple stages.

- During design, it can inform the team on which system to use. Performing preliminary bay studies can help determine the optimum structural material + system to use.
- During construction, it can confirm the right material was chosen for the project goals.

Who leads an embodied carbon calculation

It depends on the scope.

- If you only want to calculate embodied carbon in the structure, the structural engineer can lead.
- If you want to include architectural materials, then an architect that provides sustainability services or a sustainability consultant can lead and bring in the structural engineer/other consultants as needed.
- If the calculation is performed during construction, the contractor can lead.

Pros

- This assessment relies on environmental product declarations (EPDs) – they're like nutrition labels for products + materials, but instead of calories + nutrients, they provide important information about the products' environmental impacts. They can range from industry average for a material to product-specific information provided from the manufacturer. The database of EPDs provided by manufacturers is growing rapidly as requirements for them increase across the nation.

- There are several free tools online through EC3 Home or ECOM tool on the SE 2050 site.
- It's a more simplified method with less speculation if you're able to obtain the product-specific EPDs.

Cons

- Embodied carbon calculation misses out on key interactions between the structure and the building's whole life cycle by only focusing on phases A1-A3.
  - The thermal properties of the material and insulation in the building's envelope will impact the energy required to heat and cool the building, affecting the operational carbon.
- Only considering the embodied carbon of the structural materials can miss out on other materials used.
  - A steel-framed building that requires a two-hour rated fire assembly will also need fireproofing or architectural finishes to cover the steel.
  - A concrete building that requires a two-hour rated fire assembly could provide the fire-rated assembly itself, requiring no/less additional material.

Lastly, it's important to realize that any life cycle assessment is a team effort. Participation from the architect, MEP + structural engineer from early in the design process is key. Remember: the structure alone accounts for nearly 50% of embodied carbon in a building. The structural engineer can have a key role in reducing the embodied carbon of a building from material specification to the design. We can define the building's structural materials including the amount + specifications of the material. We can also provide alternate structural system options to review or provide insight into what the structural requirements are for a project. While a sustainability consultant or other expert may be the one performing the assessment, teaming with consultants that understand what the assessments are + how they're used, and how the consultant's involvement can add value to the process from an early stage will make the most impact.

blog post

mass timber trends | sustainability

Sustainability is a hot topic in the world + in the design community. Sustainability in regards to mass timber is an even more hotly debated topic.

Are mass timber buildings actually more sustainable than other buildings?

This question doesn't have a straight-forward answer, and a lot of variables should be evaluated when considering a mass timber structure if sustainability is one of your main objectives.

How to assess a sustainable structure

A life cycle assessment (LCA) is often run to measure a building's Global Warming Potential (GWP) along with other environmental impacts. Those results are compared with a similar building constructed with other materials to determine the preferred construction material option for each scenario. We recently did this for the Cincinnati Public Radio project which we'll tell you about more later, but for now, let's consider other aspects of sustainability that may not be directly measured by a life cycle assessment.

HEALTHY FORESTS

What sustainability comes down to – carbon. Healthy + growing forests are an essential component in transforming carbon into oxygen. One could argue that nothing is more important to the health of our world than keeping healthy forests. With this in mind, the majority of the forests in the United States are privately owned. The owners often need financial incentives to keep these forests thriving instead of converting them into something else like farmland. Therefore, keeping a demand for forestry, and both the harvesting + replanting of trees, is essential to give the owners a return on investment AND ultimately keep the forests healthy. Hence, all wood construction projects, including mass timber projects, help to drive that essential demand.

HEALTH + WELLNESS

Speaking of health, health + wellness of those who spend time inside of the building is an important +

blog post

sustainable aspect of mass timber.

We should not only be concerned about the health of our planet, but we should also take into consideration the health + well-being of those inside.

From my perspective, it's difficult to enter a mass timber building and leave without a smile on my face. But it's not just my opinion – there's an entire approach, called biophilic design, that focuses on nature + wellness-focused design including how natural wood elements affect occupant well-being. Check out these stats on how exposed wood office buildings affect well-being.

- "Developers also are seeing higher leasing velocity and/or lease rates for offices with natural wood environments. The developer for Clay Creative, a timber office building in Portland, Oregon, reports that tenants were willing to pay $7 more per square foot annually than a similar non-wood structure located across the river downtown."
- "Those in workplaces with a higher proportion of visible wood feel more connected to nature, and rate their working environment far more positively. These people report higher concentration, lower stress levels, and improved overall mood."
- "There is a close connection between the rate of employee absenteeism, their satisfaction at work, and the presence of wood in their workplace."

The same logic can be used for housing. This also increases the likelihood the building will maintain a useful life for a longer period of time and ultimately improve the results of a mass timber building on the life cycle assessment.

A whole building life cycle assessment is one way to measure sustainability for a structure, and other aspects are often + should be evaluated (for example, occupant well-being, natural lighting, landscaping, etc.) for a holistic look at the sustainability equation.

Cincinnati Public Radio life cycle assessment

Let's return to our Cincinnati Public Radio project as we promised above. The new Cincinnati Public Radio headquarters will be one of the first mass timber building in Cincinnati, Ohio, and will be an incredible

blog post

addition to the Keystone Parke development, Cincinnati's first LEED-certified corporate campus. The two-story facility nearly doubles Cincinnati Public Radio's previous space and will have offices, broadcast suites, a publicly accessible podcast studio and spaces for live events.

In performing the life cycle assessment on Cincinnati Public Radio with its architect, Emersion Design, we compared mass timber vs. steel construction. And the results were (DRUMROLL) mixed.

	Pro*
Mass Timber	Renewable
Steel	Recyclable at end of life
Mass Timber	Requires relatively little energy to harvest + fabricate
Steel	Larger variety of mills + fabricators (lower amount of carbon needed to transport)
Mass Timber	Temporary carbon sink where carbon is stored in the wood fibers
Steel	Growing use of EAF steel production and renewable energy to produce steel

	Con*
Mass Timber	Not local to the Cincinnati, Ohio site (high amount of carbon needed to transport it there)
Steel	High energy needed to produce + fabricate
Mass Timber	A lot of board feet of lumber resulting in some inefficiencies as not all the material is working hard from a structural perspective
Steel	Cannot sequester (store) carbon
Mass Timber	End of life uncertainties
Steel	Would require concrete slabs (large carbon footprint)

blog post

**These data points were specific to the Cincinnati Public Radio project and do not represent a complete list for comparing mass timber + steel construction materials.*

Cincinnati Public Radio chose to move forward with a mass timber structure because it's immediate sustainability benefits, erection speed, and the transformational aesthetic for its employees + the local community.

How mass timber can become more sustainable

Aside from Global Warming Potential, mass timber structures can perform poorly in a life cycle assessment in the end of life stage. Why? Because some life cycle assessment models, including what was used for Cincinnati Public Radio, assume no reuse of the material at the end of a building's useful life, whereas a material like steel is typically recycled. If mass timber ends up in a landfill or burned, the carbon stored in the material will be released back into the atmosphere and the temporary carbon sink will ultimately be of little benefit.

The main challenge before the design community is to figure out what to do with the mass timber material at the end of life. If we can crack the nut of material reuse, then we can also crack the nut of improving the overall sustainability of a mass timber building.