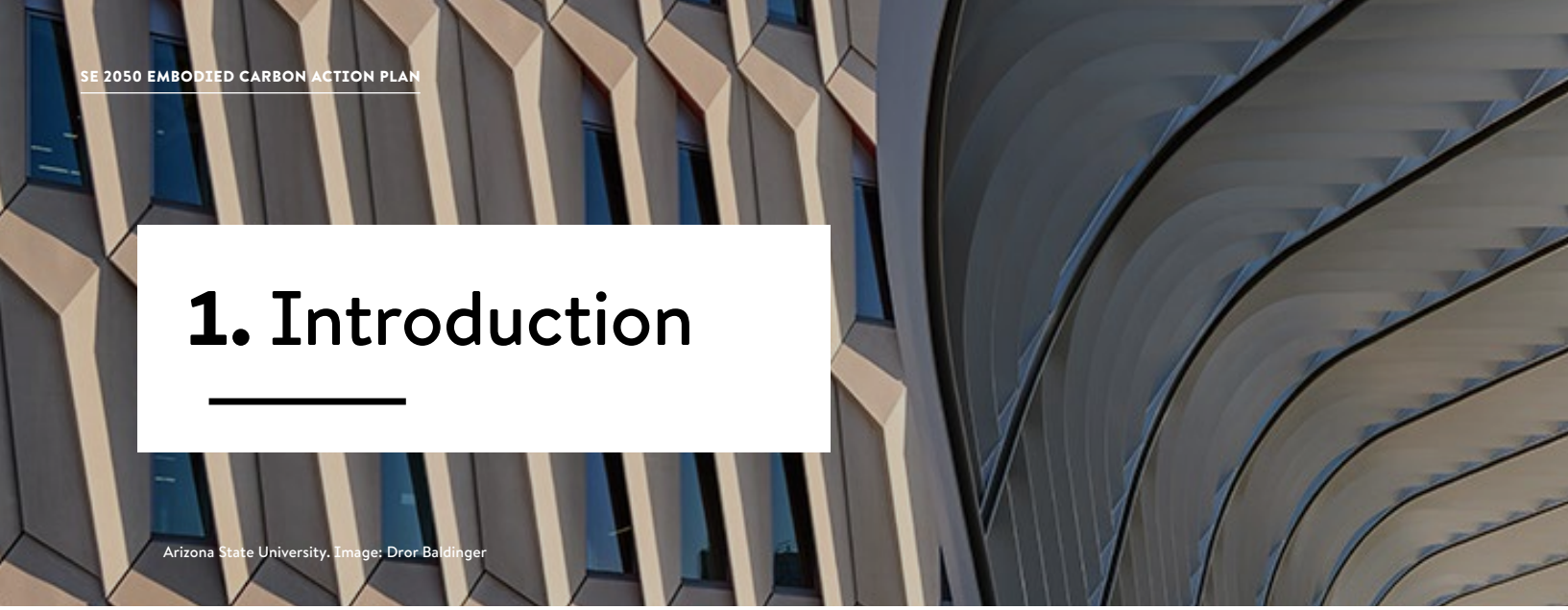
BURO HAPPOLD

SE 2050 Embodied Carbon Action Plan

2023

Contents

Quinnipiac University,
Recreation and Wellness Center
Image: Anton Grassl



Arizona State University. Image: Dror Baldinger

1. Introduction

At Buro Happold, we believe collective action is the best way to address the climate and biodiversity crisis. It is our responsibility to design and create environments that are sustainable and fair. Every engineer, consultant and advisor must put the environment at the heart of their work. If we make major reductions in greenhouse gas emissions, we can limit global warming to 1.5 degrees. This will mean environmental justice for all.

With this in mind, Buro Happold is proud to commit to the SE 2050 program with the explicit goal of achieving net zero carbon by 2050.

Buro Happold signs Structural Engineers 2050 Commitment Program

The SE2050 commitment aligns with our firm wide goals which are outlined in our annual Sustainability Report:

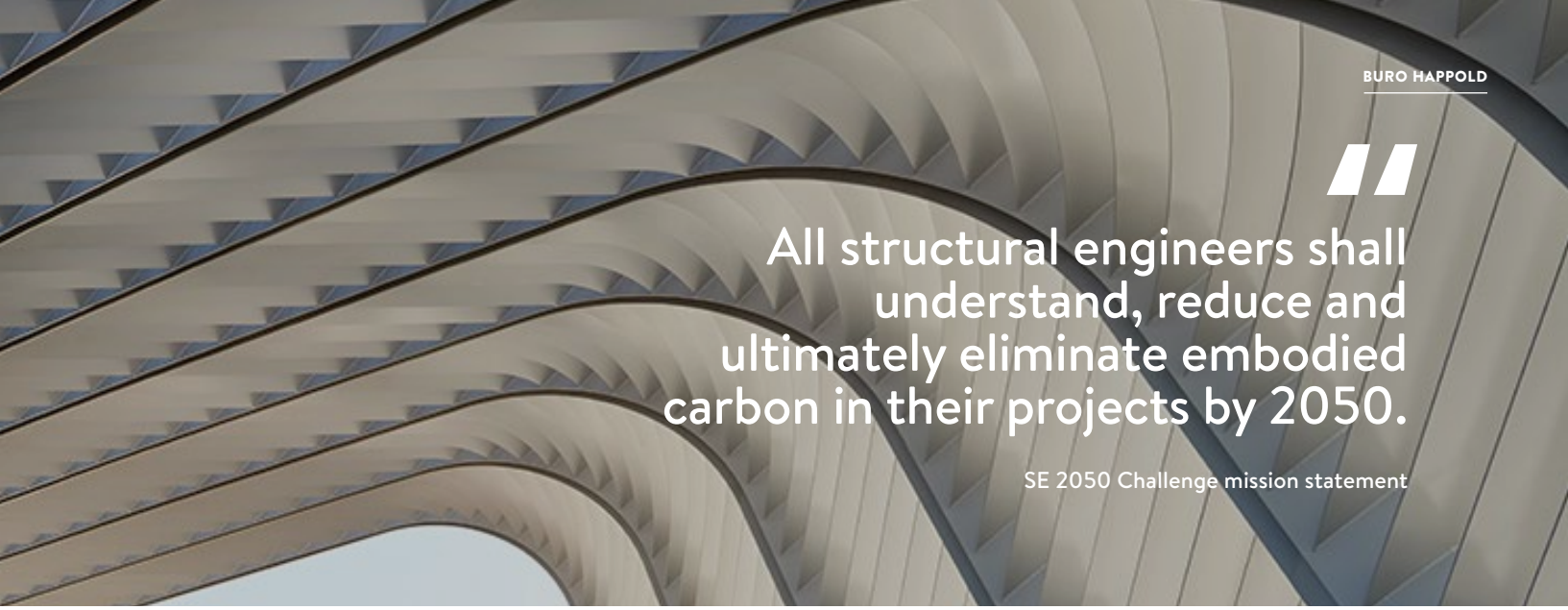
- Reduce our own operational carbon emissions by 21% by 2025 and aim to be net zero carbon from April 2021 by offsetting residual emissions.
- Design all new build projects to be net zero carbon in operation by 2030.
- Reduce embodied carbon intensity of all new buildings, major retrofits and infrastructure projects by 50% by 2030

At Buro Happold, we pride ourselves in our problem-solving acumen through our multidisciplinary expertise. With a challenge as complex and far reaching as climate change, we must leverage the collective knowledge and experience of all parties. Buro Happold is committed to leveraging the skills of our various disciplines (Structures, MEP, facades, sustainability) in order to tackle this issue to the fullest extent.

Only together can we begin to set forth a future that is sustainable, equitable, and just.

We believe our biggest responsibility is to shift from sustainability goal setting and planning, into action and implementation... Our vision is that everywhere we live, work, move and socialise will respect and contribute to a more equitable world, enabling our clients and partners to develop built environments that are better for people, places and planet.

— Oliver Plunkett, CEO



> All structural engineers shall understand, reduce and ultimately eliminate embodied carbon in their projects by 2050.
>
> SE 2050 Challenge mission statement

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October 6, 2021

Laura Champion
Director
Structural Engineering Institute

Dear Laura,

Buro Happold North America 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.

Buro Happold is committed to regularly reporting and holding ourselves accountable to our people and the wider industry. We are on a route map to net zero carbon through the following targets:

1. Reduce our own operational carbon emissions by 21% by 2025 and aim to be net zero carbon from April 2021 by offsetting residual emissions.
2. Design all new build projects to be net zero carbon in operation by 2030.
3. Reduce embodied carbon intensity of all new buildings, major retrofits and infrastructure projects by 50% by 2030.

We therefore commit Buro Happold North America to take the following steps which are part of the SE2050 Commitment Program:

- Within six months and annually henceforth, we commit to reporting an Embodied Carbon Action Plan (ECAP) and permit the ECAP document on form be made public on the SE 2050 website.
- Within one year and annually henceforth, 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.

On behalf of Buro Happold Consulting Engineers P.C.

S. Curtis

Stephen Curtis
Principal
Buro Happold
stephen.curtis@burohappold.com

Buro Happold's SE 2050 commitment letter

2. Education

Education is a pivotal step in tackling climate change. Only with a common understanding of the impending climate crisis can we begin to take steps to reduce the environmental impacts of the built environment. Buro Happold's North America Region has taken significant steps to educate our team about the importance of sustainability and how as structural engineers we can influence the impact of our designs.

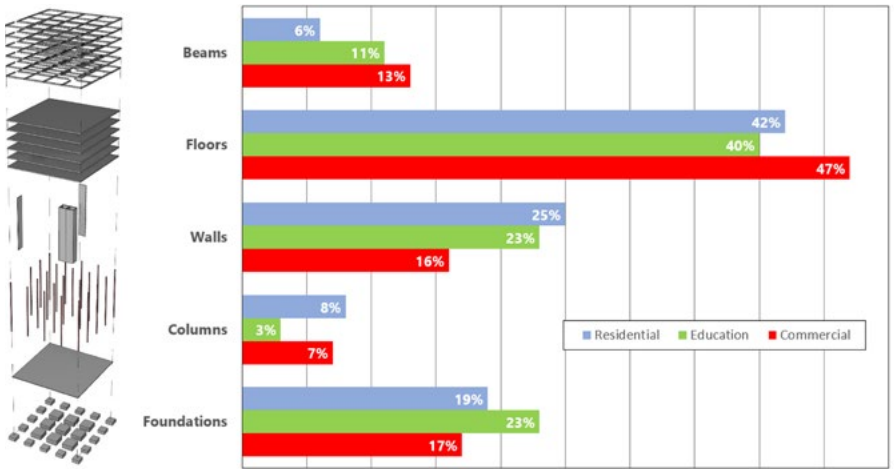
In the last year Buro Happold's North America structural teams convened for a series of events focused initially on establishing an appreciation and understanding of this topic and how to bring about change. These included:

- **Structural Engineers Forum** to discuss the engineer's role in reducing embodied carbon and the influence they can have throughout the design process.
- **Embodied Carbon Optimization Onboarding Meetings** to demonstrate the process and opportunities on our projects to new hires.
- **Embodied Carbon Reduction Case Studies and Standards Meeting** to showcase progress made across these topics and how to implement these on projects.
- **BHoM Life Cycle Assessment Toolkit Training** to educate structural engineers on methods for calculating and tracking embodied carbon using proprietary tools.
- **"Embodied Carbon and how to calculate it"** as part of a series, "Buildings-Structures: Outline Proposals for Global Training in Relation to the Climate and Biodiversity Crises."

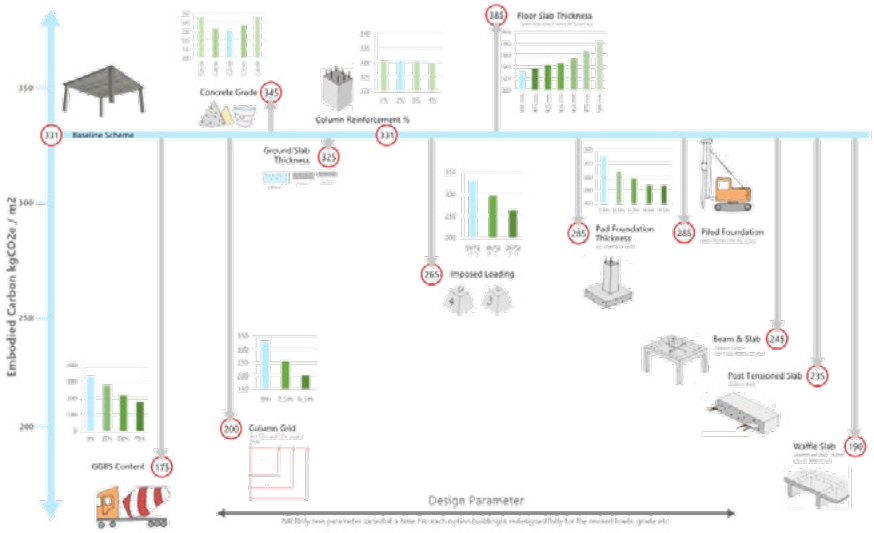
Providence River Pedestrian and Bicycle Bridge. Image: Kroo Photography

The SE2050 initiative is targeting halving embodied carbon in our structures by 2030 and getting it to zero by 2050. It is a lofty goal, but actually it is aligned with the goals Buro Happold set out within our Global Sustainability Report. Many organisations across the engineering community share the same ambition, and it is great to see different strands of industries start to think about taking action: we need all strands to tackle their own challenges if we are to make a difference.

Stephen Curtis, US Structures Regional Discipline Director
Embodied carbon and timber in the USA: in conversation with Buro Happold experts



Structural embodied carbon sensitivity study – by element



Structural embodied carbon sensitivity study – concrete frame

Our 13 North America offices are connected through a network of local champions who led our efforts on embodied carbon and host regular Sustainability in Structures Task Group meetings and participating in global Sustainability Community Regional Leads meetings.

Stephen Curtis
Principal,
Regional Discipline Director

Fraser Reid
Associate Principal,
SE 2050 committee

Luke Lombardi
Senior Sustainability Consultant,
CLF Member, SE 2050 committee

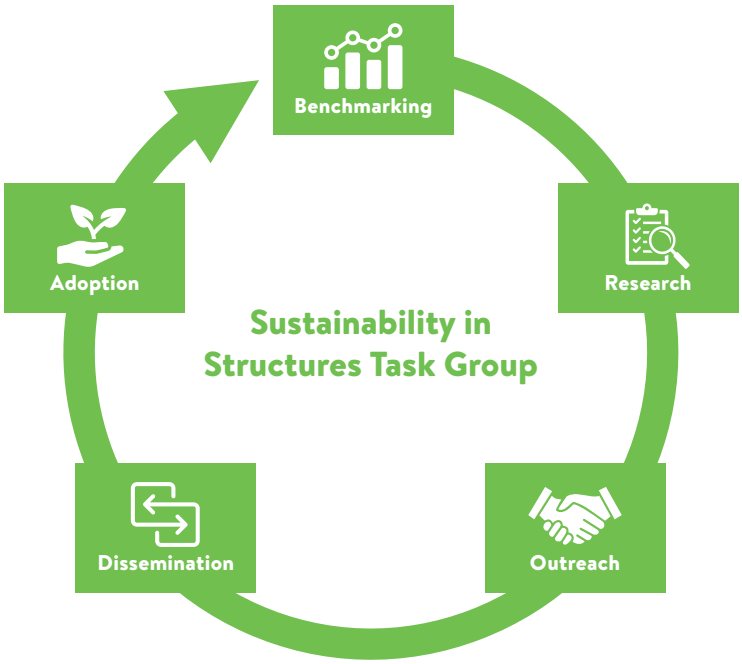
Luke Bastian
Graduate Struct. Engineer
SE 2050 committee

New York,
Boston, Seattle,
Washington D.C,
Los Angeles, Atlanta
Minneapolis, Durham,
Chicago, San Diego,
Pittsburgh, Detroit,
& San Francisco

The current focuses of the Sustainability Task Group is:

- **Benchmarking** – establishing embodied carbon metrics for current and completed projects
- **Research** – undertaking studies to determine where embodied carbon sensitivities lie in structural designs
- **Outreach** – connecting with industry partners to discuss trends and potential opportunities.
- **Dissemination** – sharing information and best practice guidance from national and global industry partners.
- **Adoption** – driving the uptake of embodied carbon measurement on new projects and reflecting on emerging trends.

Over the last year we have seen an increase in the interest and awareness of embodied carbon within the industry. This has ranged from collaborators asking that we share our knowledge and experience to clients indicating EPD targets for materials.



TProvidence River Pedestrian and Bicycle Bridge. Image: Kroo Photography

Carnegie Mellon University, Tepper Quad Project. Image: Albert Vecerka | Esto

3. Reporting

In 2019, Buro Happold released an open source Life Cycle Assessment (LCA) toolkit inspired by the Global Climate Strike. The LCA toolkit sits within Buro Happold's own Building and Habitats objects Model (BHoM), an open-source platform for code collaboration and cocreation for the AEC industry. The LCA toolkit was born out of a mission to quantify the environmental impact of materials in a transparent way with no payment barrier.

This mission aligns perfectly with BHoM's open-source origin. With BHoM at its core, the LCA Toolkitit allows users to access BIM data from Rhino or Revit, move that data into Grasshopper, Dynamo or Excel, and ultimately export the results to visualization engines or databases for closer inspection.

This toolkit consists of tools for measuring the embodied carbon of any building material at any stage of design. By harnessing the power of computation, we are able to measure the embodied carbon of a given building element modelled in any software and compare that to benchmarked datasets.

This toolkit is useful for early comparative studies as well as being listed as an approved tool by International Living Futures Institute for Living Building Challenge. The BHoM Life Cycle Assessment Toolkit has also been awarded a 2020 American Institute of Architects (AIA) Innovation Award.

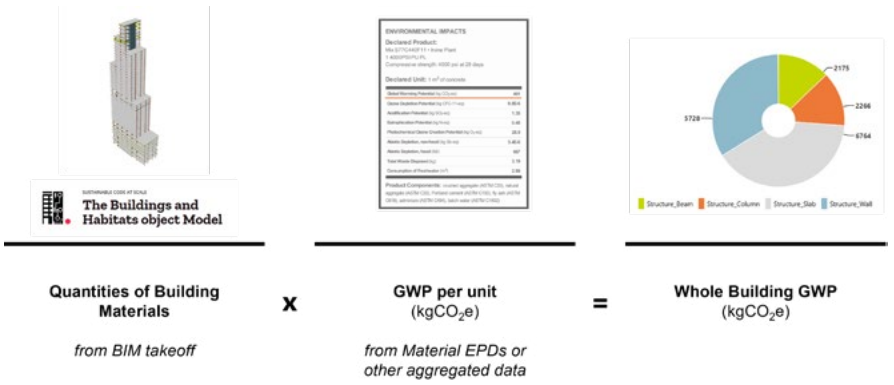
Our current focus is on determining the embodied carbon of our projects for stages A1-A3, 'Cradle to Gate' using national average Environmental Product Declarations (EPDs) where available. We see opportunity for further specificity for future projects during the later project phases particularly given our Construction Document language requiring contractors to submit data for the actual product materials used and supplied.

Our internal benchmarking process has resulted in broad awareness and uptake of the LCA toolkit consolidated by hands on training from members of the North America Regional Sustainability Champions.

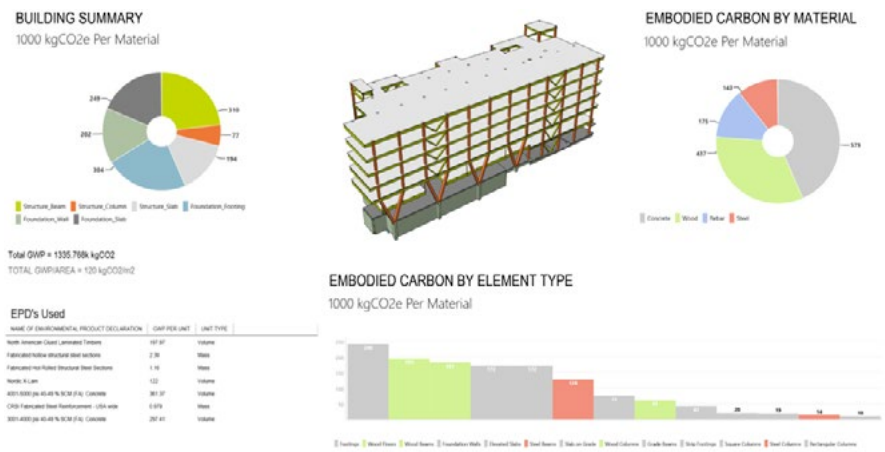
In the past year, Buro Happold submitted five projects to the SE 2050 Database and is committed to submitting a further five (5) projects to the SE 2050 Database in the coming year.

> This is a demonstration of the power of the collective to build a machine and develop a taxonomy for the industry. It could have a profound impact on the way we do things."

Jury comment from the 2020 Innovation Awards for the BHoM Life Cycle Assessment Toolkit



Structural embodied carbon calculation



Structural embodied carbon reporting

4. Embodied Carbon Reduction Strategies

Innovation is deeply engrained in the history of Buro Happold, through early pioneering work with tensile membrane structures to delivering world class iconic buildings. Throughout this history our clients have valued our efficient designs and sustainable approach to structural engineering. Reducing the embodied carbon of our designs is an extension of this history and a key aspect of our global firm wide sustainability goals. We aim to reduce the embodied carbon intensity of our designs by 50% by 2030.

As we seek to achieve that goal we are making embodied carbon intensity a key metric in our design process, to be considered together with more established metrics including design requirements, constructability and cost.

We have identified an array of strategies and focuses to reduce embodied carbon in our designs. These include:

Material choice – explore more structural framing options and consider hybrid approaches.

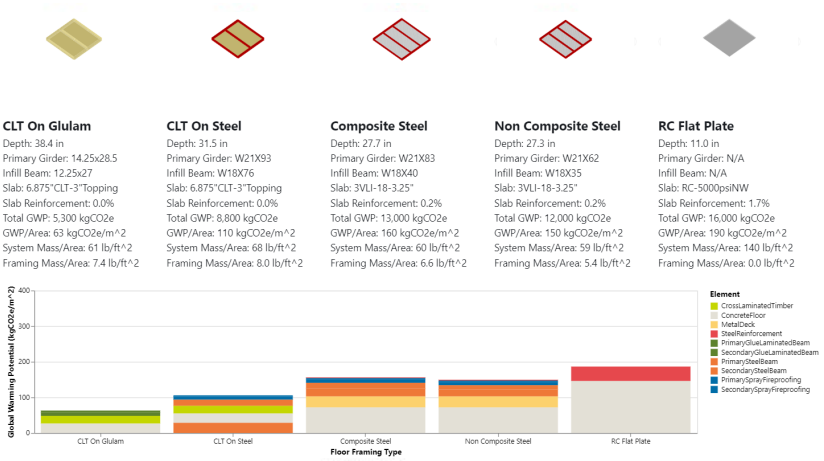
Comparative analyses – under comparative analyses of embodied carbon intensity during the initial project phases to assist in material selection decisions.

Material usage – optimize the usage of the materials selected.

Material specification – through our designs, Specifications and General Notes documents drive reductions in embodied carbon, the uptake of new technologies and accountability within the industry.

Embodied Carbon tracking – track embodied carbon intensity during the later project phases.

We are seeing some clients join us in establishing goals to reduce embodied carbon in their projects. Either through challenging us to demonstrate how we will drive reductions or by placing embodied carbon requirement on aspects of the project



Example of Comparative Floor Framing Analysis Dashboard

The focus in year one will be on developing, establishing and embedding processes and procedures into our workflows as well as determining embodied carbon metric for completed designs/ projects through a benchmarking process.

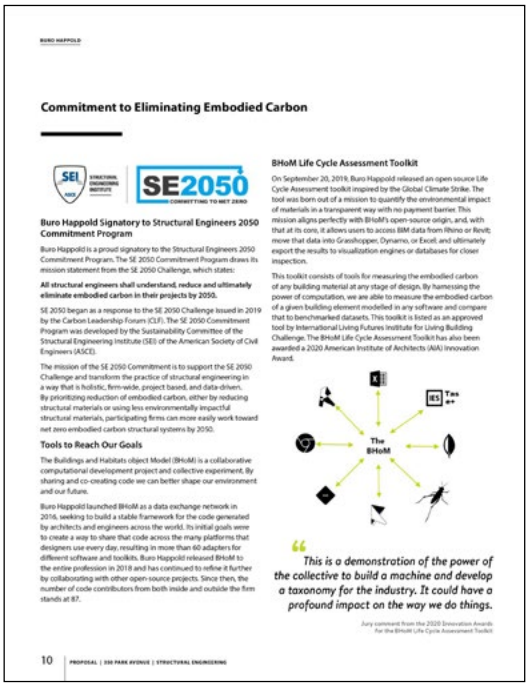
There after our goals are to reduce embodied carbon by circa 15% every two years as we work towards the 50% reduction goal for 2030.

Harvard University, Science and Engineering Complex. Image: Brad Feinknopf

5. Advocacy

At Buro Happold we recognize the role that embodied carbon holds in a broader building decarbonization effort and embraces structural engineers as critical gatekeepers for reducing embodied carbon. Structural engineers hold tremendous credibility within the design team. We exist to ensure that a building is safe to inhabit. By being a messenger for embodied carbon and reduction strategies relating to structure, that responsibility is extended to a safe planet to inhabit for future generations.

We seek opportunities to share this perspective with our clients, both those that have ambitious carbon reduction goals as well as those who are just learning about the importance of embodied carbon. We achieve this by highlighting our commitment and our approach in qualifications documents as well as including for embodied carbon and life-cycle assessment scope in our offerings.



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Commitment to Eliminating Embodied Carbon

SE2050 COMMITTING TO NET ZERO

Buro Happold Signatory to Structural Engineers 2050 Commitment Program

Buro Happold is a proud signatory to the Structural Engineers 2050 Commitment Program. The SE 2050 Commitment Program draws its mission statement from the SE 2050 Challenge, which states:

All structural engineers shall understand, reduce and ultimately eliminate embodied carbon in their projects by 2050.

SE 2050 began as a response to the SE 2050 Challenge issued in 2019 by the Carbon Leadership Forum (CLF). The SE 2050 Commitment Program was developed by the Sustainability Committee of the Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE).

The mission of the SE 2050 Commitment is to support the SE 2050 Challenge and transform the practice of structural engineering in a way that is holistic, firm-wide, project based, and data-driven. By prioritizing reduction of embodied carbon, either by reducing structural materials or using less environmentally impactful structural materials, participating firms can more easily work toward net zero embodied carbon structural systems by 2050.

Tools to Reach Our Goals

The Buildings and Habitats object Model (BHoM) is a collaborative computational development project and collective experiment. By sharing and co-creating code we can better shape our environment and our future.

Buro Happold launched BHoM as a data exchange network in 2016, seeking to build a stable framework for the code generated by architects and engineers across the world. Its initial goals were to create a way to share that code across the many platforms that designers use every day, resulting in more than 60 adapters for different software and toolkits. Buro Happold released BHoM to the entire profession in 2018 and has continued to refine it further by collaborating with other open-source projects. Since then, the number of code contributors from both inside and outside the firm stands at 87.

BHoM Life Cycle Assessment Toolkit

On September 20, 2019, Buro Happold released an open source Life Cycle Assessment toolkit inspired by the Global Climate Strike. The tool was born out of a mission to quantify the environmental impact of materials in a transparent way with no payment barrier. This mission aligns perfectly with BHoM's open-source origin, and, with that at its core, it allows users to access BIM data from Rhino or Revit; move that data into Grasshopper, Dynamo, or Excel; and ultimately export the results to visualization engines or databases for closer inspection.

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"This is a demonstration of the power of the collective to build a machine and develop a taxonomy for the industry. It could have a profound impact on the way we do things.

Jury comment from the 2020 Innovation Awards for the BHoM Life Cycle Assessment Toolkit

10 | PROPOSAL | 350 PARK AVENUE | STRUCTURAL ENGINEERING

Sample Buro Happold qualifications document

Arizona State University, ISTB7. Image: Buro Happold

In addition Buro Happold is an active advocate about embodied carbon within the wider industry, through committee participation, presentations, articles and publications.

Structures Congress

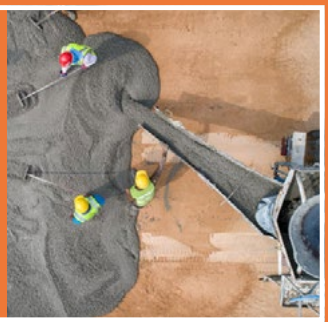
How Embodied Carbon Policies are Changing Structural Engineering Practice

May 6, 2023

ConcreteZero

US Climate Action Summit, UK Signatory and US Advocacy

April 19, 2023



ENR

SE 2050 is in Quixotic Pursuit of Eliminating Embodied Carbon in Building Structures

December 21, 2022

Structural Engineers Association of Southern California

Sustainable Building Design Through the Lens of Adaptive Reuse

March 29, 2023

SEAOSC
STRUCTURAL ENGINEERS ASSOCIATION OF SOUTHERN CALIFORNIA

Buro Happold

Embodied Carbon and Timber in the USA: in Conversation with Buro Happold Experts

March 20, 2023

Buro Happold

Can mass and hybrid timber construction support solving the challenge of embodied carbon?

March 20, 2023

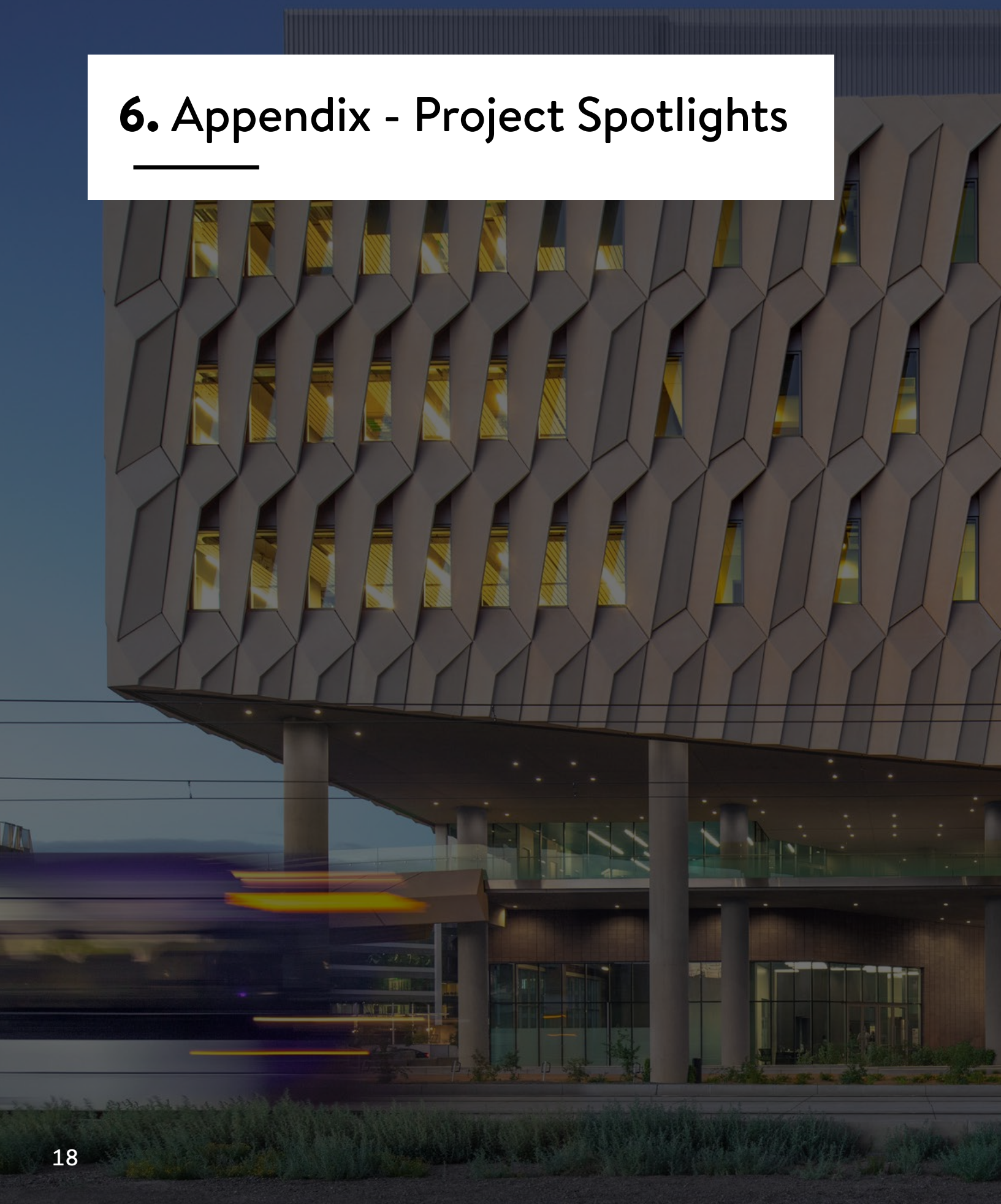
Our goal for the future is to continue our work towards holistic carbon assessments, drive the adoption of low carbon technologies, and approaches and to share our lessons learned.

We are proud to support the SE 2050 initiative and highlight this to our collaborators.

Buro Happold signs Structural Engineers 2050 Commitment Program

Crystal Bridges Museum of American Art. Image: Timothy Hursley

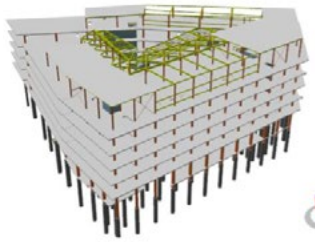
6. Appendix - Project Spotlights



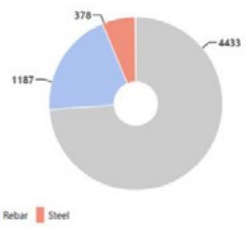
> Buro Happold is clear in its mission to be recognised as a leader in sustainability. We must focus on delivering a sustainable and equitable built environment, delivered with the power of collective action across our industry.

Duncan Price, Partner and Global Sustainability & Climate Change Lead at Buro Happold

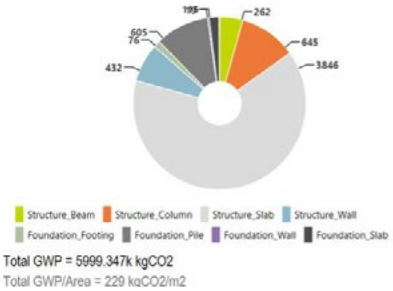
Arizona State University,
Rob and Melani Walton Center for Planetary Health
Image: Bill Timmerman



kgCO2e Per Material



kgCO2e Per Structure Type



- Contribution of floor slabs to total structural GWP = 64%
- Elevated slab GWP reduction:
  - 1% reduction using high fly ash concrete (40% SCM)
  - 9% reduction using BubbleDeck system for long span floors
  - 1,700,000kg total CO_2 eliminated; equivalent to 370 passenger vehicles driven for one year

Image: McCarthy

Arizona State University, Rob and Melani Walton Center for Planetary Health

Tempe, AZ

Completed in 2022

A high performing interdisciplinary research center

Services

- Structural engineering
- MEP engineering
- Lighting design
- Energy analytics
- Facade engineering

The Rob and Melani Walton Center for Planetary Health, formerly known as the Interdisciplinary Science and Technology Building VII (ISTB7), is a new 281,000ft2 research facility and comprehensive addition to Arizona State University's (ASU) growing research district on the Tempe campus. The building opened in April 2022.

The high-performance research facility features leading-edge research, including innovative endeavors focusing on the sustainability of food, water and energy. The facility promotes an interdisciplinary approach to knowledge generation and leading-edge research intent on improving life on the planet.

Buro Happold implemented several ambitious strategies for reducing the embodied carbon of the structure.

Floor systems were targeted as an area where innovative materials could enable embodied carbon reductions. A 'voided slab' system was used, removing concrete from within the floors by using plastic bubble-like forms in the deck. The voided slab application (also known as 'BubbleDeck') reduced concrete volume in the slabs by approximately 25% and was used for about 50% of the elevated floors. This was the first project in Arizona to use the BubbleDeck system.

Our team also implemented a performance specification for a 40% reduction in portland cement that McCarthy Building Cos., elected to meet using a 40% fly ash replacement, instead of 20%. The two-pronged attack reduced concrete by 1,300 cu yd and carbon by 40% over the initial design.

These choices came with risks and challenges, which the team ultimately navigated through close collaboration between engineer, architect, and contractor alike. Our team's approach helped not only meet ASU's carbon goals but create an example for other building teams seeking to reduce embodied carbon in concrete buildings.

Left image: Bill Timmerman

Images: Lake|Flato Architects

University of Pennsylvania, Amy Gutmann Hall

Philadelphia, PA, USA

Completion expected in 2024

Cutting-edge facilities for collaboration, research and data

Philadephia's first mass timber building

Teamed with Lake | Flato and KSS Architects, Buro Happold is providing structural engineering together with MEP, lighting design and analytics services for the University of Pennsylvania on a new Data Science Building, Amy Gutmann Hall.

The 116,000ft^2, mass timber building's planned academic features include active learning classrooms and collaboration spaces; a data science hub; research centers for new socially aware data science methodologies and novel, bio-inspired paradigms for computing.

The building will be Philadelphia's first Mass Timber building, and at 6 stories, it will one of the tallest Mass Timber structures in the region.

The mass timber structural system both reduces the building's carbon footprint by 52% relative to concrete and 41% relative to steel and creates a warm, tactile and welcoming environment

Services

- Structural engineering
- MEP engineering
- Lighting design
- Analytics

Quinnipiac University, Recreation & Wellness Center

Hamden, CT

Completed in 2022

Lifting student wellbeing with nature-inspired design

The new Recreation and Wellness Center at Quinnipiac University, in Connecticut, brings together clinical health, mental health, and recreation under a single structure in support of "whole-body wellness" for its students. The 55,000ft^2 scheme – an extension to the existing athletics building – is designed using principles of biophilia, drawing on the rich Connecticut landscape beyond and utilizing heavy timber, wood panelling, local stone, and interior green walls. The building creates a new healthy living programme with classes in cooking, nutrition, and other lifestyle elements, as well as introduces a new central courtyard for student gathering or quiet contemplation

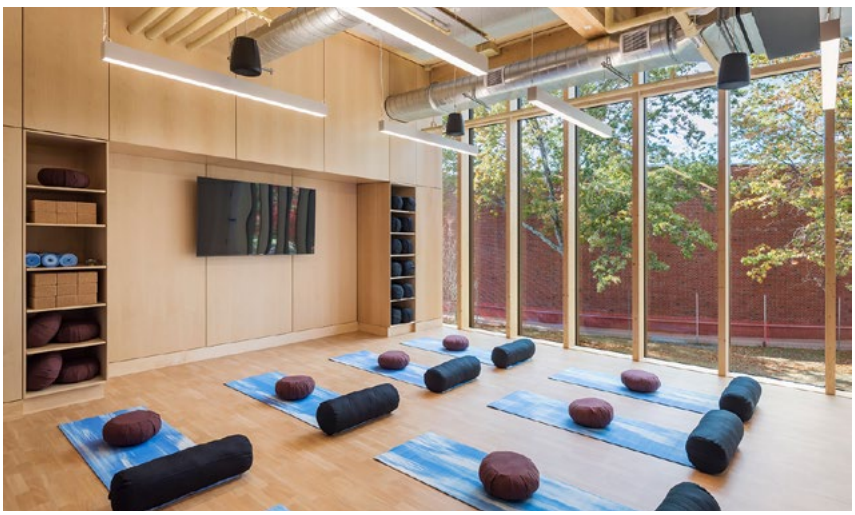
The project had high aspirations for both wellness and sustainability. Designed in accordance with LEED Gold sustainability standards, a strong use of timber was favoured as a way of reducing the overall embodied carbon of the structure. Mass-timber roof beams and CLT floor panels were utilized alongside steel beams to create an efficient and elegant hybrid system.

Special attention was also paid to the integration of the new and old structures. A new electric room was built within the existing building footprint, in what was formerly a storage area, and another back-of-house space was converted to be the new mechanical room to avoid additional new construction. A future-proofing provision was also incorporated to ensure the heating and cooling plants can be expanded, in the event of the building ever being further renovated or extended.

Images: Anton Grassl

Services

- Structural engineering
- MEP engineering
- Lighting design
- Energy modeling
- Security
- Audio-visual



BURO HAPPOLD

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