BURO HAPPOLD

SE 2050 Embodied Carbon Action Plan

April 2022

Contents

The High Line. Image: Nick Harris

1. Introduction

Kean University, Highland Campus. Image: Buro Happold

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:

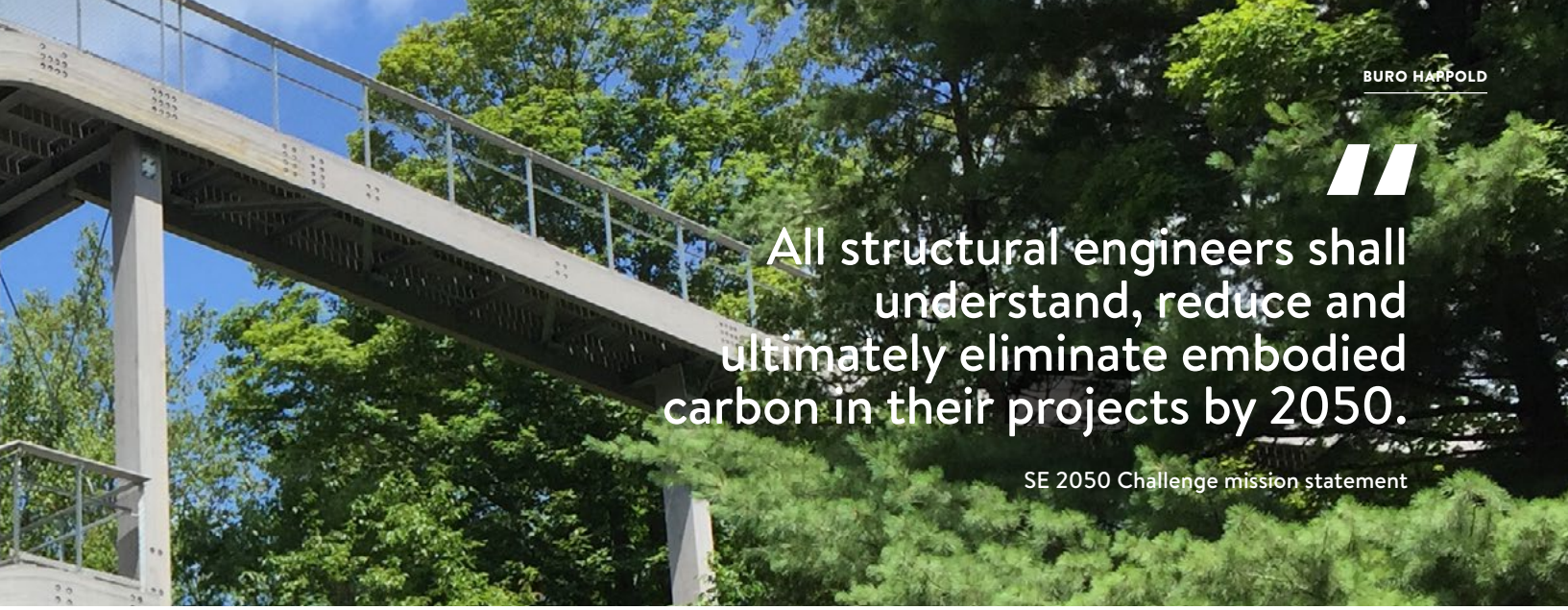
- Reduce our own operational carbon emissions by 21% by 2025 and aim to be net zero carbon from April 2021 by offsetting residual emissions.
- Design all new build projects to be net zero carbon in operation by 2030.
- Reduce embodied carbon intensity of all new buildings, major retrofits and infrastructure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

Buro Happold remains committed to reporting and holding ourselves accountable to our people and the wider industry, and this 2021 Global Sustainability Report outlines clearly how we are progressing along our sustainability journey.

— James Bruce, 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

SE 2050 COMMITMENT PROGRAM

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.

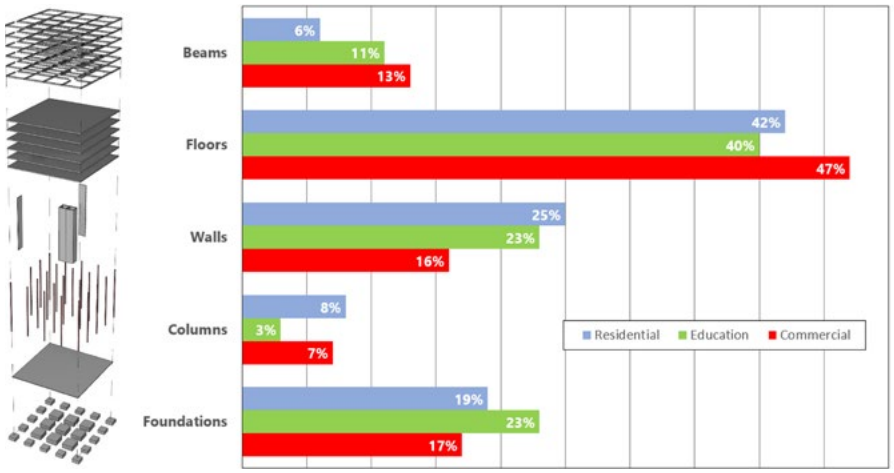
In 2021 Buro Happold's North America structural teams convened for a series of events focused initially on establishing an appreciation and understanding of this topic and how to bring about change. These included:

- **Structural Engineers Forum** to discuss the engineer's role in reducing embodied carbon and the influence they can have throughout the design process.
- **Structural Engineering Carbon Reduction Design Workshop** to discuss and explore future pathways to implementation of embodied carbon reduction strategies.
- **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"

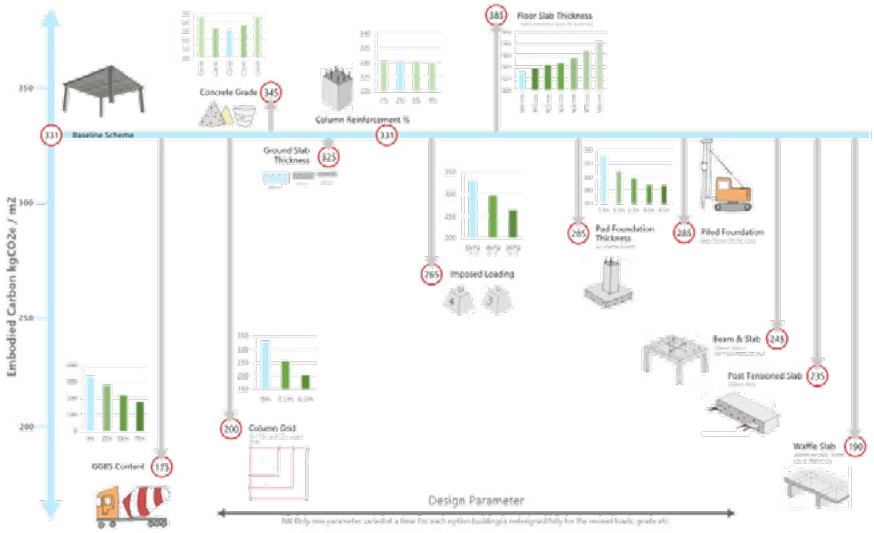
Providence River Pedestrian and Bicycle Bridge. Image: Kroo Photography

> This is more than just a concrete and steel issue... We know we will need to educate and explain to the other stakeholders on our projects why this issue is important and what may be viable alternate options, whether that means timber construction or other alternate technologies."

Stephen Curtis, US Structures Regional Discipline Director
Buro Happold pledges to eliminate embodied carbon in projects as part of SE 2050 commitment



Structural embodied carbon sensitivity study – by element



Structural embodied carbon sensitivity study – concrete frame

Our 12 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

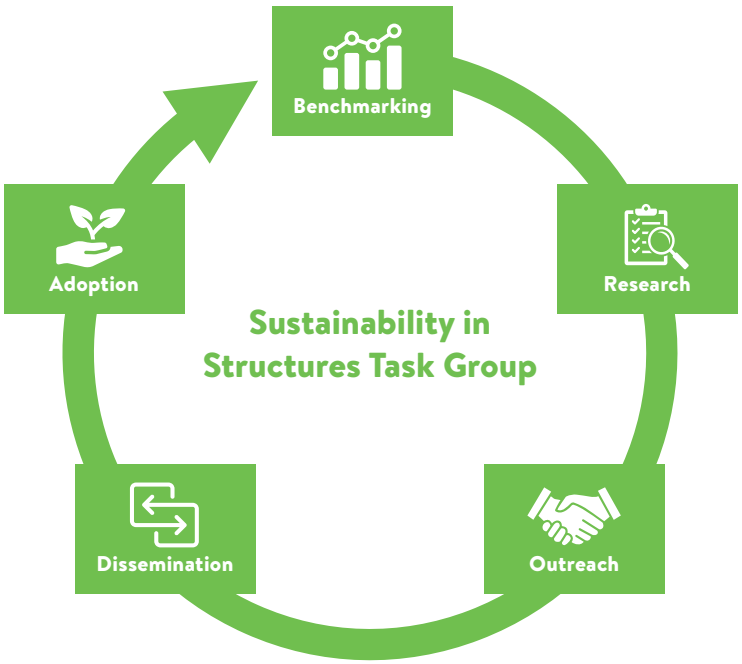
Manuel Chafart
Structural Engineer,
SE 2050 committee

New York,
Los Angeles,
Boston, Seattle,
Minneapolis, Durham,
Washington D.C,
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.

Looking ahead into 2022 we anticipate information sessions focused around emerging low carbon structural technologies and materials as well as further events to share development and progress with the team.



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.

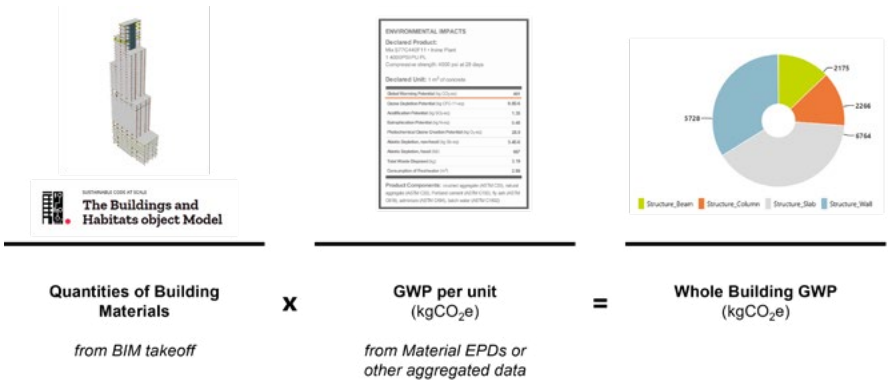
Our current focus is on determining the embodied carbon of our projects for stages A1-A3, 'Cradle to Gate' using national average Environmental Product Declarations (EPDs) where available. We see opportunity for further specificity for future projects during the later project phases particularly given 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.

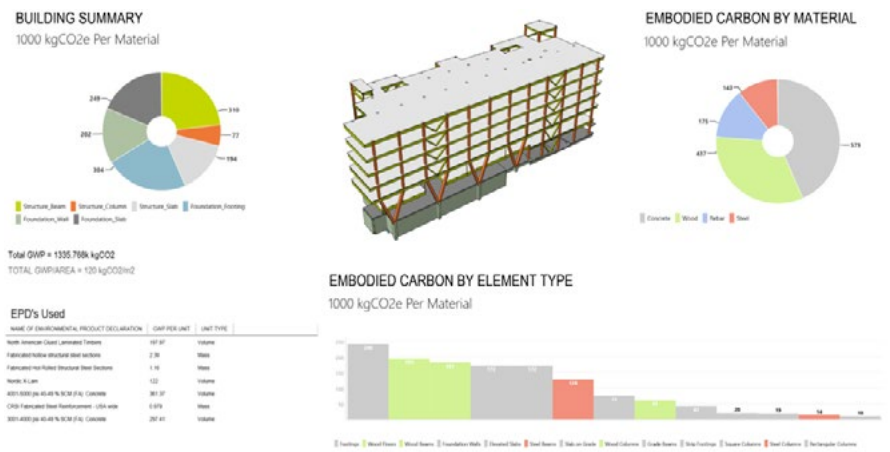
We are committed to submitting five (5) projects from the North America region to the SE 2050 Database.

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.

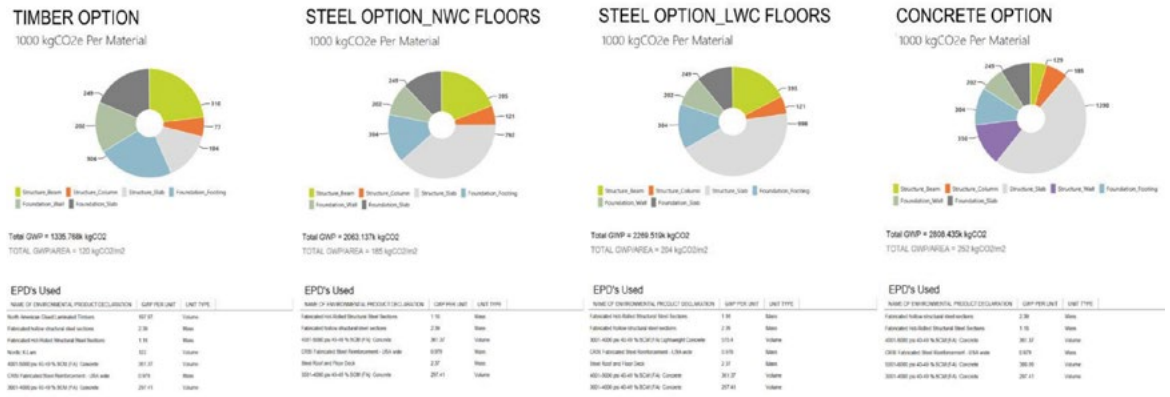
Comparative analyses – under comparative analyses of embodied carbon intensity during the initial project phases to assist in material selection decisions.

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.

Example of comparative embodied carbon analysis



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.

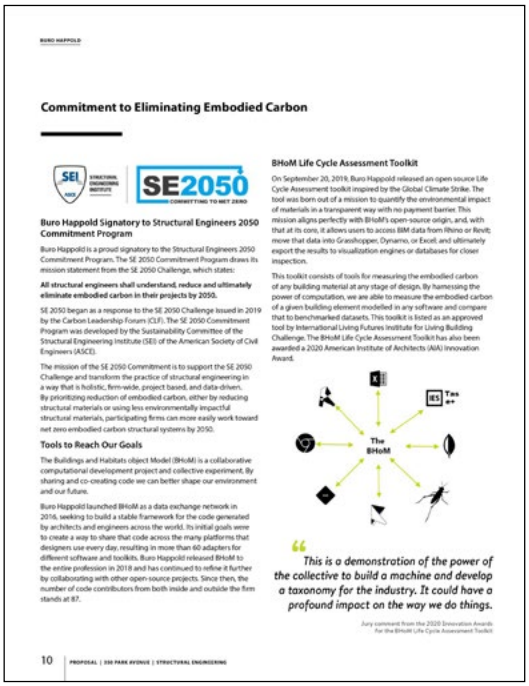
There after our goals are to reduce embodied carbon by circa 15% every two years as we work towards the 50% reduction goal for 2030.

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.



BURO HAPPOLD

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.

Lab Manager

Project Profile: ASU Interdisciplinary Science and Technology Building 7 (ISTB7)

March 15, 2021

commARCH

Buro Happold Structures Create Greener, Safer Campuses

February 12, 2021

Dezeen

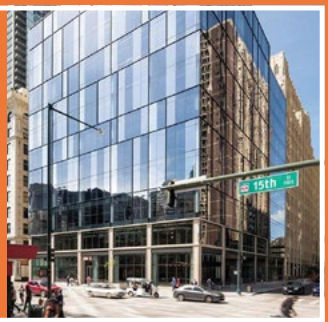
Buro Happold pledges to eliminate embodied carbon in projects as part of SE 2050 commitment

January 20, 2021

Architectural Record

Continuing Education: Embodied Carbon & Adaptive Reuse

February 1, 2022



Structural Engineers Association of New York

How to Measure Embodied Carbon and Perform LCA in Your Structural Design

November 17, 2021

The Institution of Structural Engineers

Embodied carbon: structural sensitivity study

April 2, 2020

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

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

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

Images: Buro Happold

Arizona State University, Interdisciplinary Science and Technology Building VII

Tempe, AZ

Completed in 2022

A high performing interdisciplinary research center

ASU's ISTB7 will be a new 281,000ft2 research facility and comprehensive addition to Arizona State University's (ASU) growing research district on the Tempe campus. The high-performance facility will feature leading-edge research, including innovative endeavors focusing on the sustainability of food, water and energy. ISTB7 will also have laboratory spaces for biological sciences, engineering, life sciences and sustainability. Dry lab space includes computing, cyber-security ,engineering design and fabrication, and robotics

In addition to being designed to achieve LEED Gold, the project team developed a series of strategies to pursue further sustainable design goals. One such goal was minimizing embodied carbon. The structural design responds to this by using a voided slab system, prefabricated voids cast into the reinforced concrete slabs, which reduce the volume of concrete and thus embodied carbon when compared to an equivalent solid slab. In addition, high cement replacement targets have been placed on the concrete throughout, further reducing embodied carbon in the building.

Services

- **Structural engineering**
- **MEP engineering**
- **lighting design**
- **analytics**

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 116,000ft2, 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

Carnegie Mellon University, Tepper Quad Project

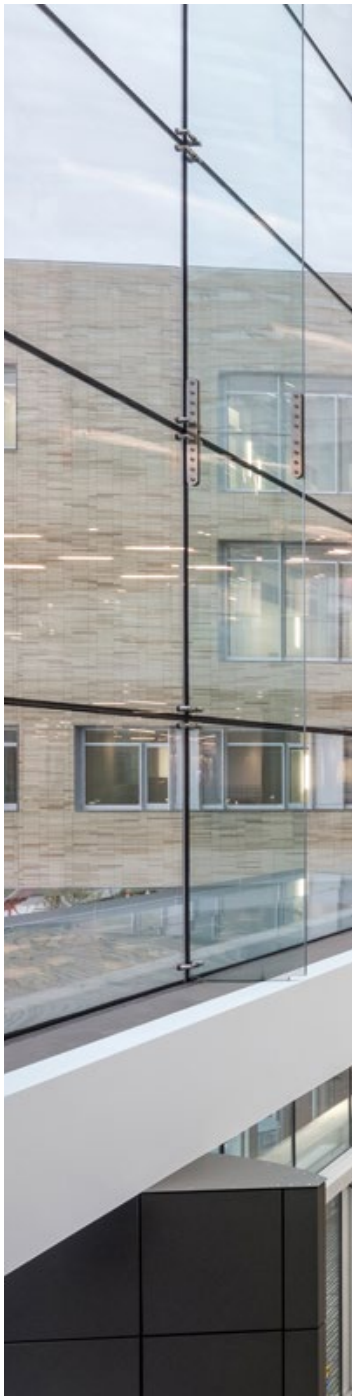
Pittsburgh, PA

Completed in 2018

An innovative bubble deck business school

As a hub for technology-enhanced learning and research, the five-story business school features 305,000 ft^2 of collaborative, flexible spaces for students and staff.

Using significantly less concrete than traditional slabs, our efficient voided slab structure considerably reduced the embodied carbon of the building. In combination with our loft style design for the MEP systems, which integrated services distribution in the ceiling voids, this solution also allowed us to save floor to floor height as well as approximately nine feet from the total building height in line with planning limits.



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

Services

- Structural engineering,
- facade engineering,
- MEP engineering
- fire engineering
- energy modeling,
- daylight/sunlight analysis,
- ICT and security,
- sustainability/LEED

Awards

- 2019 WAN (World Architecture News) Awards, Materials, Concrete in Architecture, Finalist
- 2019 AIA|LA COTE Award, Educational, Citation Award

BURO HAPPOLD

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