VERDANT
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EMBODIED CARBON ACTION PLAN: 2022

At Verdant Structural Engineers, we aim to perform carbon conscious designs. We specialize in projects utilizing optimal and efficient use of conventional building materials as well as projects utilizing environmentally sensitive building materials and methods such as straw bale, hemp-lime (hempcrete), rammed earth, cob, adobe, super adobe, earthbag, and bamboo. VSE works closely with the natural and green building community to develop standards and procedures for green building practices.
We support the vision that all structural engineers shall understand, reduce, and ultimately reach net-zero embodied carbon in their projects by 2050. During our second year of participation in the SE2050 movement, we commit to implementing and completing the action plan outlined below.

EDUCATION: Understanding Embodied Carbon

1. **Embodied Carbon Reduction Champion**:

   Nora Murray will continue in the role of ECRC.

2. **Embodied Carbon Webinars**:

   All new engineering staff will be asked to watch the following three webinars as part of the on-boarding process within the first three months of joining the Verdant team.
   Boston Society of Architects “Embodied Carbon 101” sessions listed below:
   Required: Embodied Carbon 101: Basic Literacy
   Required: Embodied Carbon 101: Procurement
   Elective: Embodied Carbon 101: One additional session of choice

3. **Education Electives**: (2 required, 4 recommended)

   1. **(Required)** Distribute ECAP within our firm upon publishing.
   2. **(Required)** Make (1) webinar focused on embodied carbon available to employees.
   3. Have one representative of our firm attend a quarterly education program provided by SE2050, Carbon Leadership Forum, or other embodied carbon resources.
   4. Nominate one representative of our firm to participate in a Carbon Leadership Forum Community Hub and/or task force.

5. Plan (2) firm-wide presentations per year on the topic of embodied carbon. Verdant's topics of interest include reduction strategies, carbon storage in biogenic materials such as using Straw Structurally Insulated Panels (S-SIP).
6. **(Completed)** Attend a presentation or demo of an LCA-based tool used to calculate embodied carbon, specifically Building Emissions Account for Materials (BEAM).
7. Present and discuss the materials optimization article IStructE, "Rationalisation Versus Optimisation–Getting the Balance Right in Changing Times," Structure, Oct. 2020.

4. **2021 Education Electives**: (1 required, 4 recommended)

1. **(Not completed)** Have one representative of our firm attend a quarterly education program provided by SE2050, Carbon Leadership Forum, or other embodied carbon resources.
2. **(Completed)** Share the SE2050 library of resources with our staff.
3. **(Completed)** Share the embodied carbon reduction strategies as outlined in "Top 10 Carbon Reducing Actions for Structural Engineers" document produced by SE2050.
4. **(Not Completed)** Nominate one representative of our firm to participate in a Carbon Leadership Forum Community Hub and/or task force.
5. **(Completed)** Share the document "How to Calculate Embodied Carbon" with our staff.
6. **(Not completed)** Attend a presentation or demo of an LCA-based tool used to calculate embodied carbon, specifically Building Emissions Account for Materials (BEAM) and EC3.

KNOWLEDGE SHARING:

We will share our firm's efforts and lessons learned with our clients, the design community, and public by adding a SE2050 Commitment Update post on our company website and sharing the post on social media. The update will include our BEAM LCA data summary, embodied carbon intensity comparison of our two projects, and a conclusion of our findings highlighting the highest embodied carbon contributors and the benefits of using carbon storing materials such as straw bale insulation.

EMBODIED CARBON REDUCTION STRATEGY: Action Steps

1. **Reduction Goal**:

   Our embodied carbon reduction strategy will be to continue to collaborate with contractors to use reduced embodied carbon concrete mixes, encourage the use of carbon storing insulations such as cellulose insulation, and optimize material usage by challenging staff to fully utilize a 1.0 design ratio based on the discussion points presented in the article by IStructE, "Rationalisation Versus Optimisation–Getting the Balance Right in Changing Times," Structure, Oct. 2020, listed as a Materials Optimization resource on the SE2050 website.

Education and Training: Our goal is to increase our technical staff's embodied carbon literacy through the Education electives, and encourage staff to attend webinars on the topic of embodied carbon reduction strategies.

Concrete Embodied Carbon Reduction: Our goal is to continue to engage with contractors for 80% of our projects and collaborate on procuring reduced carbon concrete mix designs from suppliers. We will request concrete mix designs and collect data for SCM percentages used. Our goal is to quantify the carbon reduction using a conventional normal weight concrete mix as a baseline.

2. **Reduction Strategies Electives**: (1 required, 4 recommended)

    1. Collaborate with concrete suppliers to reduce carbon in mix designs.
    2. Work with a contractor during material procurement to meet an embodied carbon performance criteria on at least one project.
    3. Incorporate biogenic materials on at least one project.
    4. Complete an embodied carbon comparison study during the project concept phase.
    5. Create a project-specific embodied carbon reduction plan.
    6. Communicate the embodied carbon impacts of different design options with the client for one project.

3. **2021 Reduction Strategies Electives**: (1 required, 4 recommended)

    1. **(Completed)** Collaborate with concrete suppliers to reduce carbon in mix designs.
    2. **(Not completed**) Work with a contractor during material procurement to meet an embodied carbon performance criteria on at least one project.
    3. **(Completed)** Incorporate biogenic materials on at least one project.
    4. **(Completed)** Integrate embodied carbon mitigation strategies in our General Notes.

REPORTING: Embodied Carbon Data

1. **Getting The Data:**
    For our second-year commitment, we will continue to use the BEAM LCA tool to quantify embodied carbon for A1-A3 (cradle-to-gate) stage. BEAM has been formally released and is available for free download. We have selected this tool because it provides embodied carbon data for carbon storing materials. We may also incorporate EC3 available resources to find EPDs to inform design decisions, product comparison, and procurement options. Material quantities to be used/input into the BEAM tool will be calculated with a spreadsheet using our construction documents, with the understanding that actual material quantities used in construction may vary. In the future, we would like to transition to BIM modeling to extract material quantities.

2. **LCA Internal Training**:
    We will focus on training additional staff on how to use the BEAM LCA tool.We hope to train a minimum of two additional staff members, for a total of four staff

members with BEAM LCA tool proficiency in the office. Each staff member will perform one of the LCA projects that we will submit to the SE2050 database.

3. **Reporting Commitment**:
   For our second-year commitment, our goal is to submit embodied carbon data for four projects to the SE2050 database. The projects will be strategically selected to be of similar size and complexity. Ideally, one project will be a conventionally wood framed structure and the others will include biogenic, carbon storing materials, and concrete mixes with 50% SCM or greater.

4. **Reporting Electives**: (1 required, 2 recommended)

   1. **(Required)** Submit a minimum of 2 projects per US office with structural engineering services to the SE 2050 Database. Not required to submit more than 5 total projects across your firm.
   2. Report a greater number of projects than submitted the previous year.

5. **2021 Reporting Electives**: (not required, 1 recommended)

   1. **(Not Completed)** For a project submitted to the database we will ask the architect and owner for a carbon budget or a sustainability goal at the kickoff meeting.

ADVOCACY: Spreading the Word

1. **Marketing**:
   We have been and will continue to share our knowledge via social media posts, webinars, and conference presentations to bring awareness to industry partners of ways to reduce embodied carbon in the built environment. All new technical staff will be asked to add the SE2050 logo to email signatures to bring awareness to our collaborators that we have joined the commitment.

2. **Proposals**:
   Language declaring our commitment to SE2050 will be added to our proposal template.

3. **Advocacy Electives**: (2 required, 4 recommended)

   1. **(Required)** Describe the value of SE2050 to clients. Collaborate with the design team to reduce embodied carbon. Attach any associated marketing materials.
   2. **(Required)** Declare your firm as a member of the SE 2050 Commitment with boilerplate proposal language.
   3. Encourage industry and policy change by promoting and using low-carbon and carbon sequestering materials.
   4. Share education opportunities with clients.
   5. **(Completed)** Discuss with the client the option of requiring that some of the structural materials come with facility-specific or product-specific EPDs.

4. **2021 Advocacy Electives**: (not required, 2 recommended)

1. **(Completed)** Share our commitment to SE 2050 on our company website.
2. **(Not Completed)** Discuss with the client the option of requiring that some of the structural materials come with facility-specific or product-specific EPDs.
3. **(Completed)** Share education opportunities with clients.

LESSONS LEARNED: 2021 First Year Commitment

For our first-year commitment data, we performed a LCA (A1-A3) on two residential ADU structures of comparable size and complexity. ADU 'A' was constructed with conventional wood framing methods, cellulose insulation, and a conventional concrete mix. ADU 'B' was constructed with prefabricated straw insulated panels, cellulose insulation, a 50% SCM concrete mix, and followed the Residential Green Building Checklist, earning 106 points out of 456 points possible.

Using the conventionally framed ADU 'A' embodied carbon as a baseline, we observed a notable reduction in the embodied carbon for ADU 'B' as a result of using the SCM concrete mix, and more biogenic carbon storing materials (both straw and cellulose insulation).

Embodied Carbon Intensity as calculated by the SE2050 Database:
ADU 'A' = 197 Kg CO2e/m^2
ADU 'B' = 116 Kg CO2e/m^2.

According to the LCA results, the embodied carbon offset provided by the biogenic insulation materials used in ADU 'A' (cellulose) provided 1475 Kg CO2e of carbon storage, resulting in a 12% storage offset in embodied carbon. For ADU 'B', the straw insulation provided 2,187 Kg CO2e of carbon storage and the cellulose insulation provided an additional 815 Kg CO2e of carbon storage, resulting in a total of 34% storage offset in embodied carbon. Using the 50% SCM concrete mix reduced the embodied carbon by 6%. Resulting in a 40% net embodied carbon reduction for ADU 'B'.

For both ADU 'A' and ADU 'B' we observed that both windows and cladding were major contributors to the total embodied carbon of the structure, comparable to that of concrete. As structural engineers, windows and cladding fall outside of our scope, however, this new knowledge can help us collaborate with the design team in highlighting carbon reducing pathways.

The BEAM LCA tool we used includes data for carbon storing materials and provides an easy to read breakdown of total embodied carbon, carbon storage, and net embodied carbon for each material and for the total building. This enables us to see which components of the structure are the major contributors to the total embodied carbon and can help inform our reduction strategies more effectively.

Summarizing the lessons learned:

1. Carbon storage by means of biogenic materials (insulation) is a significant way to reduce embodied carbon.
2. In addition to using SCM concrete mixes, also consider optimizing the foundation design to reduce concrete volume.
3. Architectural finishes (windows and cladding) are significant carbon contributors.