LONG-TERM CARE OF THE PLANET

Building materials play role in mitigating embodied carbon in healthcare facilities

By Jay Burtwistle & Éléonore Leclerc

Rendering courtesy Stantec/HDR Architecture Associates Inc.

As the impacts of climate change continue to accelerate, the associated complexities deepen. There needs to be greater emphasis on addressing the root causes of climate change in a holistic way. Nowhere is this more apparent than in healthcare projects, which aim to deliver health and well-being outcomes while limiting the associated impacts on the planet of operating these facilities.

Over the past decade, much has been learned and advanced in reducing the operational impacts associated with buildings. Additionally, various codes and standards have continued to drive ever greater reductions in operational emissions.

As operational carbon has been gradually reined in by these codes, there has been a corresponding recognition that building materials have a considerable effect on the planet and on a facility's overall carbon picture. However, there are several unique considerations in the healthcare context that influence the ability to reduce embodied carbon emissions.

LIFE CYCLE ASSESSMENT

A life cycle assessment (LCA) is the process by which the associated impacts for a product, process or service can be quantified over the stages of its life. The International Organization for Standards (ISO) has outlined two ways (14040 and 14044) to help define and describe LCAs consistently across all markets and applications.

ISO 14040 defines the system boundary of whole building LCAs (wbLCAs) according to several stages. Once someone has performed a LCA on specific products and developed results into environmental product declarations (EPDs), software can help aggregate the EPDs and incorporate all building products within the scope of analysis to determine the overall environmental impacts of a building in several categories. These categories vary depending on the methodology employed. For the purposes of an embodied carbon analysis, the global warming potential (GWP) indicator, which is a measure of the kilograms of carbon dioxide equivalent emissions per functional unit of product or building, is of concern.

There are many LCA tools in the market right now that can help projects analyze strategies, including OneClick LCA, Tally, Forma and Athena Impact Estimator, among others. It is recommended that teams engage a subject matter expert early on to help develop a robust LCA model capable of informing early-stage design.

PRELIMINARY INTERPRETATIONS

Using OneClick LCA as the software on a long-term care project, Stantec was able to develop results from the material quantities in the preliminary costing and create an informed analysis of different strategies to reduce the overall embodied carbon.

From this preliminary analysis of the baseline, it was learned that the majority of the embodied carbon of this project (76 per cent) was occurring during the product raw resource supply and manufacturing (A1-A3) life cycle stages. This informed the design team that they should target materials that have a carbon intensive manufacturing process. An additional 16 per cent was from transportation to the site as its location is quite rural. The project team could consider transporting materials by rail or barge to reduce these emissions, if practical to do so.

The project was analyzed through a second lens, assembly classification, which showed 56 per cent of the total embodied carbon was in the foundations and horizontal structure (slabs) and another 18 per cent was in the columns and vertical structure, which were all concrete for the baseline design. This pointed the team in the right direction for early analysis of significant reductions by targeting these most intensive assemblies.

UNIQUE CONSIDERATIONS

Through working on the long-term care project, and several other healthcare projects throughout British Columbia, a number of considerations have arisen in relation to reducing the environmental impacts of these projects, especially as they relate to embodied carbon. The first two,

▲ Views of a long-term care facility that was the subject of the life cycle assessment analysis. Renderings courtesy Stantec

climatic data and indoor environment, are relatively minor implications in relation to embodied carbon but bear contemplation during early design stages. Most of the considerations fall under a broad topic called 'materiality.'

FUTURE CLIMATE DATA

A reoccurring question on several projects has focused on what climatic data to use as baseline for the design of that project. This has significant implications for the resilience of the project over the long term. Various future climate models will require increases in heating, ventilation, and air conditioning (HVAC) equipment, consequently raising the operational and embodied carbon from oversizing equipment or providing additional measures to reduce overheating, such as solar shading devices.

CONTROLLED ENVIRONMENT

Unsurprisingly, healthcare environments require a greater level of control over the indoor thermal environment. However, several studies relate the importance of an occupant's ability to exercise control over their own environment through operable windows or accessible thermal comfort controls, along with having access to daylight and views. Examining this balance through the lens of embodied carbon, operable windows and more windows equate to an increase in embodied carbon, though results may vary depending on the embodied carbon intensity of the project's wall assemblies and window-to-wall ratio. To understand this impact, an embodied carbon analysis should be included as design decisions are made.

BUILDING MATERIALS

Sensitivity analysis can be used within LCAs to determine which building materials are the least impactful from an embodied carbon perspective. However, material choices are limited in healthcare due to several reasons.

It is important to establish the classification of the project as part of its vision since this relates to functionality after an event for residents and the surrounding community. This classification has a significant impact on the structural systems and specifications, which will in turn impact the strategies to reduce embodied carbon on a project. The higher the classification, the more material (or stronger material) required in the structure of the building, so owners and design teams should weigh the classification carefully against climate and carbon goals.

In addition to resilience of the whole building, resilience of the interior environments can also have a significant carbon impact. One analysis Stantec performed on a laboratory building indicated the resilient flooring, which would normally be excluded from a typical wbLCA as it is part of the interior finishes, would have accounted for approximately 10 per cent of the project's overall embodied carbon. Project teams should consider eliminating additional interior materials where possible and rely on the durability of finished structural materials, such as concrete, steel and mass timber.

One of the most common strategies currently being considered in projects to reduce embodied carbon is employing mass timber structural systems for all or part of the building's super structure. Several considerations that impact this choice in healthcare projects include biophilia, vibration and acoustics.

Meaning a love for nature or living things, biophilia has gained momentum in the built environment from many studies on how natural materials or even images of nature in buildings have a positive impact on the well-being of occupants.

Structural vibrations affect building occupants in several ways, as well as sensitive imaging equipment in healthcare settings. If a mass timber structure is being considered, which generally has more vibration, designers need to coordinate with the structural engineer to develop a common understanding of the vibration requirements of the project — and potentially individual spaces within it — and consider stiffening structure or using a hybrid approach where there is low tolerance for vibrations.

Acoustic performance of mass timber structures is another consideration, related to vibration. Although a completely mass timber structure will perform generally worse than stiffer, denser materials, there are several strategies available to engineers to help mitigate acoustic concerns. These can often include the introduction of technologies like special acoustic layers in floor assemblies to help reduce or eliminate sound transmittance between spaces. ■

▲ Extensive use of mass timber and timber finishing in a proposed long-term care building. Rendering courtesy Stantec/HDR Architecture Associates Inc.

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