Embodied carbon in construction

Feature

BDP's headquarters building for Swiss pharmaceutical giant Roche in Welwyn Garden City includes a 'low energy' passive chilled beam.

Carbon dioxide emissions have for some time assumed centre stage in the fight against global warming. This is because CO2 is the dominant gas released by our activities that exacerbates global warming.

Currently, most sustainability regulations focus on the reduction of CO2 emissions, and on the operation, rather than on the formation, of a building. This approach adheres to the perception that more energy is consumed by running assets than in constructing them. In contrast, when cost is considered, attention is generally focused on capital, rather than life-cycle costs. In the same way that operating and maintenance costs need detailed consideration, it is important that both the day-one carbon impact of a project and the effects of maintenance, refurbishment, and even disposal, should be understood and mitigated. This article focuses on the importance of embodied carbon and how it is assessed.

What is embodied carbon and why is it important?

The embodied carbon emissions of a building is the CO2 produced during the manufacture of materials, their transport and assembly on site, maintenance and replacement, disassembly and decomposition. While most CO2 production is associated with the burning of fossil fuels, a vast amount comes from the release of fossilised carbon stores (for example in converting limestone to cement). Initial embodied carbon is associated with the original construction, while recurrent embodied carbon relates to that associated with consumables, repairs, maintenance and refurbishment.

Embodied energy has been part of the sustainability debate for many years, but methodological challenges and the focus of regulation formation on in-use energy and carbon have kept it low on the sustainability agenda.

Images: Davis Langdon

Embodied carbon's relevance to construction

Embodied carbon emissions are worth serious consideration in construction for many reasons, including the following:

- Construction is energy intensive. The materials sector alone accounts for 5-6% of total UK emissions, so any initiative to reduce them will make a significant contribution to meeting reduction targets. Furthermore, research results suggest 70% of emissions are associated with manufacture and 15% with transport of materials. This implies that specifiers can ultimately influence the carbon footprint of buildings.
- Embodied emissions are becoming more significant as the operational emissions of buildings fall in response to anticipated regulations.
- Savings in embodied carbon emissions achieve significant "year one" reductions that could take many years to achieve through operational savings, for example, via on-site renewables or enhanced insulation. Furthermore, operational reductions are dependent on the performance of the building and could be lost through sub-optimal management or accelerated refurbishment cycles.
- Shorter design lives and refurbishment/refit cycles increase lifetime emissions, and only the embodied assessment method reflects this impact.

Although embodied carbon accounts for a large proportion of construction's carbon footprint, it is important to take note that a building-wide assessment is available so that the most readily achievable sources of emissions reductions are targeted.

How embodied carbon can be measured

There are many challenges in assessing embodied carbon emissions. Many variables affect the carbon intensity of products, including manufacture, transport, primary energy sources and the extent of waste or recycling. As a result it is difficult to calculate measures of embodied carbon unless there is a high degree of contextual knowledge, which puts a project team member such as a quantity surveyor in a good position to make an accurate assessment.

As some processes and products are more carbon-intensive than others, it is not necessary to calculate the absolute total carbon footprint of a project as many components will have a negligible impact and offer limited opportunities for mitigation. An effective approach is one that focuses on the most carbon-intense and extensively used components. The principal issues that such an approach addresses should include:

- Units of comparison. The carbon emissions mostly linked to energy consumption in the extraction and manufacturing pro cesses of different building materials. This consumption is mea sured on the basis of product mass.
- Data availability. The wider adoption of a life-cycle assessment means there are multiple sources of embodied emissions data, but this is not necessarily consistent or applicable to construction products.
- Simplifying complexity. With complex components it is helpful to separate primary components from the processes required to finish them. Many embodied carbon emissions follow mass, so a useful rule of thumb is to focus on the most numerous and heavy components. Other elements with less impact can be factored in using adjustments.
- Manufacturing energy. Measures of energy used in manufacturing complex products are not widely available, and assessments of the carbon footprint of these components needs to account for the energy intensity of all the processes involved and the basic materials.
- Data consistency and ease of use. The most reliable sources of data tend to be subscription-based databases such as SimaPro, which uses the Ecoinvent data resource. Others, such as Athena, are also used. Be careful when using data from open-access sources, as this can be inconsistent.

Making use of the assessment: Reporting and mitigation

By reporting on clients' embodied carbon footprint, project teams will be able to provide, along with existing operational carbon measures, a more rounded view of the impact of their developments. As data improves, advisers will be able to band buildings by their embodied carbon rating and clients will gain a greater appreciation of their and their project teams' roles in addressing carbon impact through:

- Intelligent specification, based on impact as well as ease of imple mentation.
- Creating demand for products with low-carbon processes.
- Encouraging demand to create market transformations in carbon-intensive sectors of the supply chain.
- Fostering an appreciation of the impact of strategies such as renewable energy technologies.
- Encouraging the use of recycled and recyclable products.
- Designing for deconstruction.

The drive to consider end of life issues has been a surprising outcome of an initiative focused initially on "year one" carbon emissions. This article is an extract from an article published by Davis Langdon (United Kingdom) in Building Magazine 12-10-2007.

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Scottish Natural Heritage's Great Glen House in Inverness used masonry, slate and flooring from its demoslished predecessor on the site.