Climate action

Measuring carbon in structures – advice for small practices

Natasha Watson aims to demystify embodied carbon assessments for smaller structural engineering firms, considering why and when these are needed, as well some practical actions to reduce carbon emissions when a full assessment is not performed.

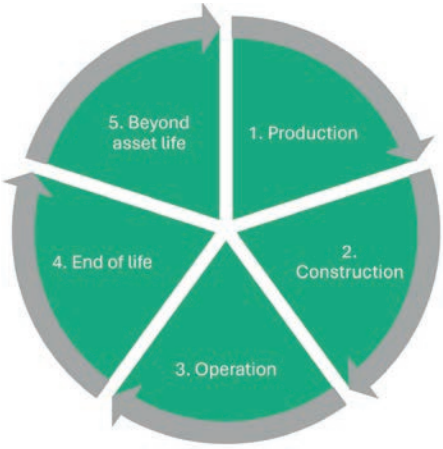
Introduction

Whole-life carbon assessments (WLCAs) **(Figure 1)** are becoming more commonplace within the built environment for large developments. Within Europe, France, the Netherlands and Denmark have already implemented legislation for whole-life carbon limits[1], and in March 2024 MEPs adopted plans to reduce energy consumption and greenhouse-gas emissions from the building sector, which includes the need to conduct WLCAs.

Within the UK, the industry-proposed Part Z of the Building Regulations **(Box 1)**, which would regulate embodied carbon of buildings, has received widespread support from firms working within the built environment.

Outside of Europe, the USA passed the Inflation Reduction Act in 2022 which addresses the impact of construction materials on climate change, putting funding behind the necessary enhanced standardisation, measurement, reporting and verification of their embodied carbon[2]. Furthermore, the latest signatories to the WGBC's 'Net Zero Carbon Buildings Commitment'[3], which encompasses the disclosure of whole-life carbon emissions according to EN 15978 or other accepted national standards, feature cities and regions from around the globe, including South Africa, Colombia, Australia, Canada, Mexico and Japan.

These commitments and legislative requirements will continue to gain popularity around the world as we all work to decarbonise the built environment.



↗**FIGURE 1:** Whole-life carbon assessments calculate carbon emissions over the lifecycle of a built asset

The structural engineer's role

The structural portion of a building typically includes the most material (48–67% of the material by mass for a new build[4]), and so structural engineers have a disproportionate impact on the carbon emissions associated with the built environment; especially since the world is moving further towards renewable resources for our energy consumption.

Although WLCAs are only anticipated to be required for larger developments at the moment, it is imperative that our members understand the impact that their designs have on carbon emissions – regardless of project size – so that we can all work towards a lower-carbon future. This article sets out what is required as a 'baseline' for our members: **whole-life carbon assessments for design**; as well as what is required if carbon is to be audited on the project: **whole-life carbon assessments for auditing**.

WLCA for design

These are assessments that are completed by structural engineers and used to either inform the designer on certain options, or to calculate the total embodied carbon of a design for educational and internal benchmarking purposes. The structural engineer will calculate the embodied carbon of their scope elements in an Excel-based tool such as The Structural Carbon Tool[5], as a calculation package in line with *How to calculate embodied carbon*[6] or other in-house calculation software that follows the IStructE guidance.

A WLCA is most likely to be required or financially justified on larger projects, but this doesn't mean the embodied carbon of smaller projects can be ignored.

Assessing and minimising carbon on smaller projects

Calculating embodied carbon for smaller projects, such as house extensions or remodelling, may be more challenging or harder to justify given the resource required. Often, the structural engineer will be working

Box 1. What is Part Z?

Part Z is a proposed amendment to the Building Regulations in England and Wales. Proposed Document Z outlines requirements on the assessment of whole-life carbon emissions, and limiting of embodied carbon emissions, for all major building projects, defined as either having a gross internal area of 1000m^2, or that create more than 10no. dwellings. The proposal introduces mandatory assessments ahead of setting carbon limits, giving time to converge on robust yet ambitious targets.

If adopted, it would rapidly accelerate the voluntary action occurring across our industry, leading to green investment and green jobs creation across construction.

→| Find out more at **https://part-z.uk/proposal**.

with the architect or contractor, with little or no contact with the end client, and/or is appointed on a time-charge. However, this is not a barrier to carrying out some level of calculation or taking steps to reduce the embodied carbon of designs.

Consider what is appropriate for your fee and project
While structural engineers have a responsibility to calculate embodied carbon for their projects, clients may not always see the value in this. Consider determining an appropriate level of assessment for different fee thresholds, but remember that while more significant embodied carbon savings can be made on larger projects, the cumulative effect of small savings across many smaller projects will also be substantial. These projects often involve the reuse of typical details, so ensuring these details are optimised can bring benefits to many projects.

Work from tender drawings
Many smaller projects don't follow traditional RIBA stages, and so decisions on when to undertake the calculations need to be determined on a more *ad hoc* basis. A tender set of drawings for these can often be treated as a construction issue, with limited scope for any changes beyond. If you do not have much experience with embodied carbon calculations, starting with this set of drawings, where the information is easily accessible, is a good way to understand the process and what the embodied carbon of your designs is typically.

Take practical steps to reduce carbon
Although earlier insights give more scope for providing alternative solutions for a reduced impact, there is typically limited scope for option studies for smaller projects. Practical considerations can become a lot more significant, and sizing can be governed by factors such as bearing sizes, edge distances and buildability considerations. There are various options that should be considered on smaller-scale projects. Examples include:

- →| reusing existing elements where possible (e.g. retaining masonry piers instead of installing a sway frame when creating new/larger openings)
- →| reducing the amount of structural material required when practical limitations aren't governing
- →| proposing timber beams instead of steel beams where possible
- →| reducing the cementitious content of concrete solutions where possible (e.g. specifying a 56-day strength instead of a 28-day strength[7], which can reduce the total cement content by between 5–20kg/m^3,and prioritising CEM II, III, IV, and V designations above CEM I).

The IStructE Sustainability Panel is planning to issue more detailed guidance on possible carbon reduction measures for small projects.

If possible, calculating the 'before' and 'after' when making these considerations can help educate you and your colleagues on the impact of different design decisions. Considering savings on an individual-element basis can be very useful for smaller projects. Price and Myers has completed several such exercises internally to try and guide engineers towards the best options (www.pricemyers.com/climate-action/cutting-concretes-impact-59).

Use basic geometry for a 'ballpark' calculation
There is often no formal BIM model or CAD drawings produced with smaller projects, with PDF markups on architectural information quite common. This means material calculation can be proportionately a lot more time-consuming. In these instances, focusing on the basic geometry of key structural elements (columns, beams, foundations, and floor build-up) to get quantities is enough to calculate a 'ballpark figure' for the embodied carbon of your solution.

Focus on modules A1–A3
Focusing on overall carbon totals for lifecycle modules A1–A3 and how they can be reduced will yield the most benefit for the smallest of projects. For extensions, try and determine the total A1–A3 emissions for the gross internal area provided.

WLCA for auditing

Within the UK, WLCAs are currently required for planning permission for major projects only. The Greater London Authority requires a WLCA for any referable applications (e.g. developments greater than 150 residential units or over 15 000m^2 outside the City of London). For Bath & North East Somerset, a major project is defined as one with over 50 dwellings or over 5000m^2 of commercial floor space. Their requirement is under review in other councils.

WLCAs are also required for sustainability assessment methods such as BREEAM and LEED. Where they are used 'formally' in these cases, they are typically carried out by an assessor (also known as 'LCA assessors', 'carbon assessors', 'embodied carbon assessors', etc.).

WLCAs carried out in this way are used at different stage gates to formally monitor progress against carbon targets as required by the client or for planning. The structural engineer will either feed information directly to an assessor, or to the cost consultant, with the cost model being used by the assessor for the WLCA. These assessments are also likely to be completed in accredited software such as OneClickLCA (https://oneclicklca.com/) and eTool (https://etool.app/).

Key watchpoints for working with a WLCA assessor

Get to know your assessor
Many assessors may be from a non-construction background; this is the same for 'in-house' assessors for larger companies, and for those externally. They may need more documentation to understand what the structural engineer is proposing (e.g. a Stage 2 report as well as outline drawings and specification); and may believe that carbon can be saved by 'swapping' materials rather than understanding the subsequent changes to the structural intent that may be required as a result of that design change. This can be mitigated through initial discussions and ensuring that there is enough fee and time to account for this increased support; or that the support is provided elsewhere. An early phone or video call with the assessor is likely to pay dividends over the course of the project.

Schedule regular check-ins
Ensure that there are appropriate review periods and meetings to check that the design being used for the audit at that point is appropriately up to date. It is important for an appropriate IRS (information required schedule) to be sent around the project team ahead of the assessment.

Cost plan or design information?
Depending on the assessor, they may require design information directly from the structural engineer or will rely on cost-plan data. It's important that one source of information is used for the assessment; as cost plans may include additional information, such as material contingency and provisional sums, that is not included on structural drawings.

Feedback

This article is intended as a first attempt at addressing the issues experienced by

> **"FOCUSING ON OVERALL CARBON TOTALS FOR LIFECYCLE MODULES A1–A3 AND HOW THEY CAN BE REDUCED WILL YIELD THE MOST BENEFIT FOR THE SMALLEST OF PROJECTS**

smaller practices and providing guidance to help them understand how they can reduce the embodied carbon of their work. If you have comments on how this can be expanded upon, improved, or how the IStructE can help further, please let us know at climateemergency@istructe.org.

Acknowledgements

With thanks to Paul Astle, Marika Gabbianelli, Ben Gholam, Orlando Gibbons, Peter Laidler, Laura Legnani, David Leversha, Peyrouz Modarres, Adam Parkes and Paulo Silva for their input into the development of this article.

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