Green Technology: Designing for Low Carbon

(Adapted from 'Barbour API' article by Niall Flanagan – Graduate Engineer)

Introduction

With the construction industry and the built environment being major emitters of carbon, reducing embodied as well as operational $C0_2$ in new builds have become paramount twin goals for designers.

AECOM has been working on solutions that might give countries such as the UK a shot at achieving publicised net zero ambitions. As is widely established, part of the problem for new-builds in the residential and commercial sectors is heavily **front loaded into the construction phase**. The embodied carbon of a typical building's fabrics are still responsible for around **70% of its overall emissions** over its lifecycle when viewed over a 60-year operation. Amongst the several causes of the UK's carbon emissions, this firmly establishes embodied carbon as the elephant in the room – especially given the recent impressive performance of the National Grid. During a week in May, it was announced that wind power contributed to over 60% of the UK's electricity for the first time in the nation's history. Clearly the spike in carbon emissions at the very start of a building's life needs to be better controlled.

We launched our **Sustainable Legacies Strategy** in April. One of the four pillars of this is something we are calling ScopeX: an initiative to reduce carbon through design that considers embodied and operational $C0_2$ across the entire project life cycle. The ScopeX approach accounts for materials, site locations, logistics and construction methods to reduce the impact of projects on the natural environment.

As you may be aware, this push has seen us develop a **new digital tool** to make inroads into that balance between embodied carbon and the operational efficiency of a material. We will learn more about this over the coming months once it is ready for use on real projects – exciting times!

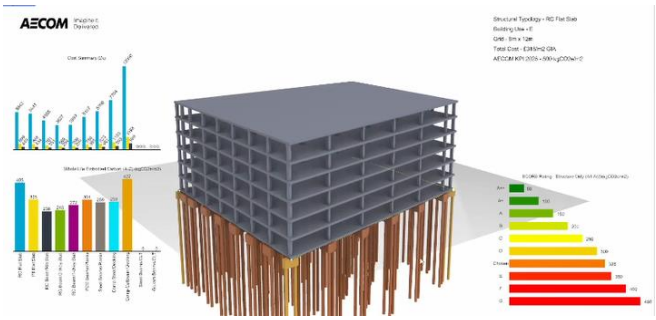
New design tool

A key aspect of our ScopeX launch is our ability to make quantitative assessments to better inform our design decisions – this tool is part of that. It's a **conceptual embodied carbon optioneering design tool**; we've released it to clients as part of our marketing campaign, and it will be launched very shortly on social media platforms. From a structural engineering point of view, we need the best form for reducing construction materials and what we should be trying to do is to find that balance between embodied carbon and operational efficiency.

Creating this tool has required significant investment in terms of money, time and resource to pull together a database containing vast swathes of structural engineering solutions for building designs. This provides options that enable a user to play with elements such as column spacing, number of bays and building area, from which it then generates carbon output. At the moment this is limited to the structure itself, but façades, MEP systems and building finishes are steadily being built into the tools to enable a more holistic approach to design optimisation.

From a geotechnical perspective, if the specific location of a project is entered – for example Aldgate Tower, the UK HQ – the tool will return the nearest project with a borehole log (an assessment of what the local strata is comprised of), enabling a material estimation for the structure's foundations. This feature draws from Google's geo-referencing database.

From a cost perspective, our cost team has provided up to date cost data for each solution, meaning that clients will have an estimation of cost inflation. Clients can use the lowest carbon solution, but they also have some gauge on what's the cheapest and most expensive, or somewhere in the middle. What we're trying to do is answer that holy grail of **what is the best choice of material and the best form of a building**. We can interface that down to this tool where the client can draw the shape of a building's footprint and see graphs of cost and carbon – enabling them to experiment with column grids and material choices (steel, concrete or timber) until their optimal solution is found.



But the key question is: **how does this interface with the operational side?**

Searching for the Holy Grail

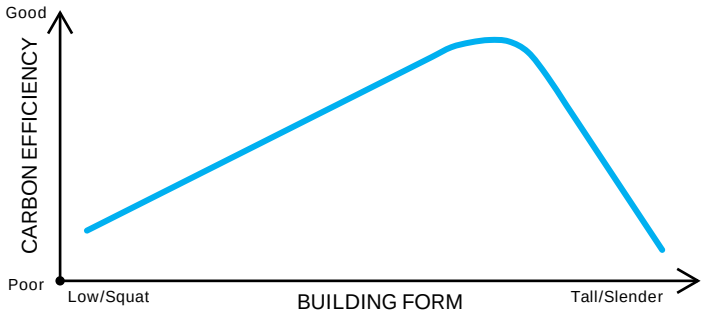
What we've tried to do within AECOM's sustainability team is look at **form factors** using case studies of different types of buildings. Specifically, we have compared how they perform from an energy perspective with the material consumption of each building.

If certain variables like internal gross area, column grid and structural material are fixed, we can then begin to find trends that reveal **optimum building heights, orientations and**

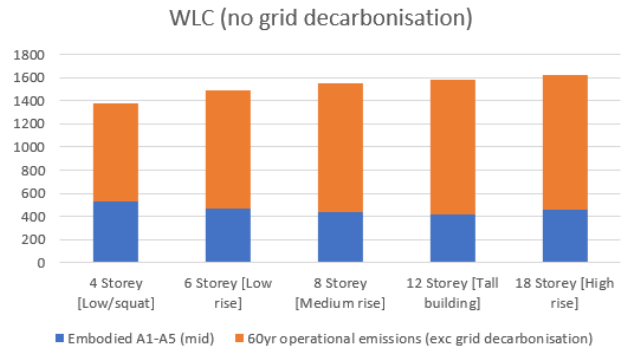
shapes in different geographies with respect to material consumption. This will ultimately help us to get closer to that net-zero agenda.

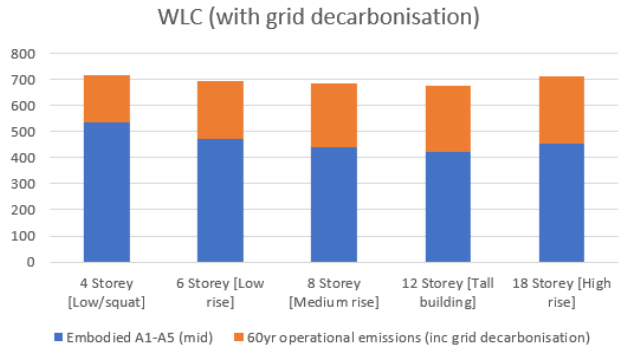
Embodied Carbon vs. Building Form Relationship

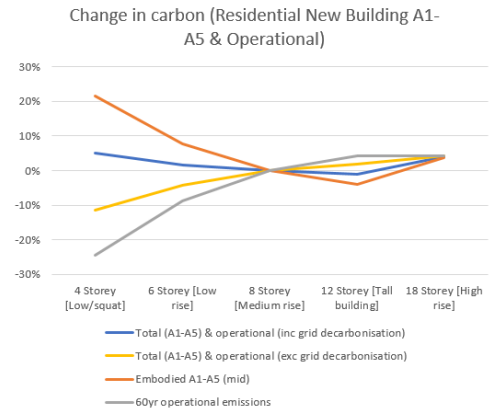
(based on piled foundations in an Urban Environment and controlled G/As)



In collaboration with the AECOM Energy team, the graphs below provide some early indicative relationships between Embodied Carbon and operational performance for a building – taking 8 storeys as a baseline. This is based on a typical concrete frame residential building with piled foundations and fixed footprint targeting optimum performance for finding the "sweet spots".







The tool allows us to carry out many of these types of thought experiment, and by analysing this data we will be producing more guidance and good practice trends in the coming months.

While a dogmatic focus on low carbon buildings clearly remains part of the solution to the low carbon jigsaw, our new design tool may be able to play a more fundamental role still. This relates to **re-prioritising the design process**. Currently – in the UK – structural engineers are included later in the design process than we probably should. As a result, what we're trying to do here is educate the industry that **engineering should probably determine the form and shape of the building**, not the architectural aspiration. Visual aids like the one provided within our tool can show that if we are focused on carbon, why don't we show the architect what the shape could be on that site and we work around that?

The incubators of innovation

Experimenting with new builds is a good way to push the low carbon drive. However, looking for CO_2 reduction in this sphere should be **viewed with a sense of proportion**. While new builds are great platforms for innovation, reducing their carbon footprints will never be the biggest mitigation for achieving net zero goals. The real difference is ultimately made in **large-scale infrastructure projects**.

Buildings provide more options to experiment and can be considered to be **incubators for ideas** due to their shorter life cycles and high level of complexity when compared to infrastructure. However, the longer life span and considerably larger material use within HS2 for example mean that the differences made are much bigger; thus, the stakes are much higher.

Summary

While there is no silver bullet to achieving net zero new-builds, and effectively addressing the vast swathes of existing estate must remain a major priority, initiatives such as these are at least collectively pulling in the right direction.

References

Original Article – written by Damon Schünmann, Strategic Consultant at Barbour API – can be found here:

https://www.barbour-abi.com/green-technology-designing-for-low-carbon/

If you are interested in learning more, Niall can be contacted at:

niall.flanagan@aecom.com

LinkedIn

Checked by: Jack Brunton.

Verified by:

Approved by:

Jack Brunton, *Principal Engineer* | **Adam Parkes**, *Regional Director* | **Jon Leach**, *Director*