Kate Simonen

Kate Simonen has been promoting the cause of embodied carbon reduction in structures for the past decade through the Carbon Leadership Forum. Now the Institution of Structural Engineers in the UK and the Structural Engineering Institute in the USA have put their weight behind initiatives to drive embodied carbon down to zero by 2050. She spoke to Jackie Whitelaw.

IN JUNE LAST YEAR, UK structural engineers declared a climate and biodiversity emergency and recognised the active role they have to play in cutting the roughly 40% of global carbon dioxide emissions which building and construction currently contribute to climate change (**Figure 1**).

Organisations large and small, from multinationals to small practitioners, have signed up to change working practices and advice to clients in order to push that percentage down and help the UK meet its 2050 zero-carbon ambitions.

The UK declaration mirrors a campaign launched in the USA in December 2019, known as the SE 2050 Challenge, which is supported by the Structural Engineering Institute (SEI) of the American Society of Civil Engineers. This also unites a group of structural engineers to ensure 'substantive embodied carbon reduction in the design and construction of our structural systems by the collective structural engineering profession'. The mission is to reach structural systems with net-zero embodied carbon by 2050.

While there is a great deal of thought and energy from a lot of people going into the charge for net zero with these initiatives, behind them is one woman and her need to gather real data on embodied carbon in structural systems and materials. That woman is Kate Simonen, currently a professor of architecture at the University of Washington in Seattle, USA and founder, a decade ago, of the Carbon Leadership Forum (CLF).

The CLF is an industry–academic collaboration hosted at the University of Washington with the goal of eliminating embodied carbon in buildings and infrastructure by inspiring innovation and spurring change through collective action. It is a professional community of manufacturers, designers, builders and academics collaborating to pioneer research, create resources, foster cross-collaboration, and incubate member-led initiatives. SE 2050 was developed and incubated at the CLF.

Eureka moment

Fifteen years ago, Simonen, who trained as an architect and structural engineer, had her own practice and became involved with a group interested in prefabricated energy-efficient homes. 'We were going to import high-performance curtain wall panels and design homes to bring operational energy down to virtually nothing. But I asked myself, can you really claim to make a great low-energy house if you are importing material from as far away as China, for instance? What is the eco cost and the carbon cost of that journey and how much carbon was emitted in making the materials?' Simonen remembers.

'Everyone at the time was focused on reducing energy in operation to affect carbon emissions – for typical buildings the great majority is in building operation, it's a big number, it's the obvious to go for first. But I knew that in structural engineering terms, the most impact I could make was in the smaller piece of the pie, the area of embodied carbon – that is, the carbon emitted in extraction, transportation and energy required to make the materials that go into a new building. I wanted to know what the low-embodied-carbon options were of various types of concrete, steel, cladding and so on, in order to make an informed decision as to what was best.'

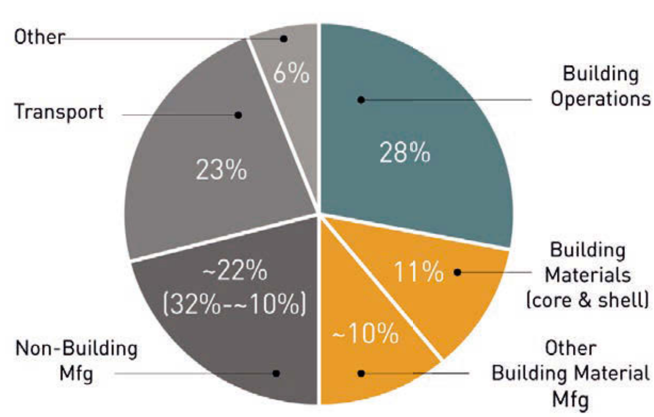
There was no obvious, unbiased place to source that information, so Simonen decided she had better find out for herself.

'I decided to move into academia so that I could work it out,' she says. 'Is it better to use local wood or import energy-efficient structure? I wanted to spend time answering those questions and I searched for an academic position that would allow me to do that.'

Holistic outlook

Simonen was an attractive proposition for a university. After studying architectural engineering as a degree, she followed it with graduate degrees at the University of California, Berkeley in advanced structures and architecture. Simonen then worked for five years as

FIGURE 1: Global CO_2 emissions by sector



Adapted from 2019 Global Status Report, Global Alliance for Building and Construction (GABC) and Architecture 2030.

● The building and construction sector has a vital role to play in eliminating carbon, as it is responsible for at least 39% of global carbon emissions.

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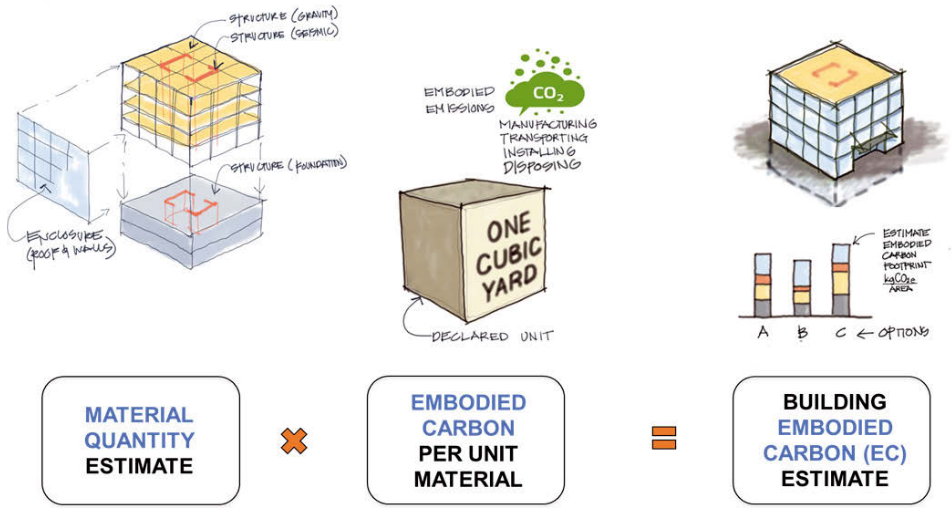


CLF

a structural engineer with a range of practices in San Francisco, on projects including seismic upgrades and new construction.

After working for several years in a mid-sized architectural firm, her next step was to set up and run her own architectural practice. The result was a great understanding of how architects and engineers work together to create structures, insight that undergraduates would find invaluable.

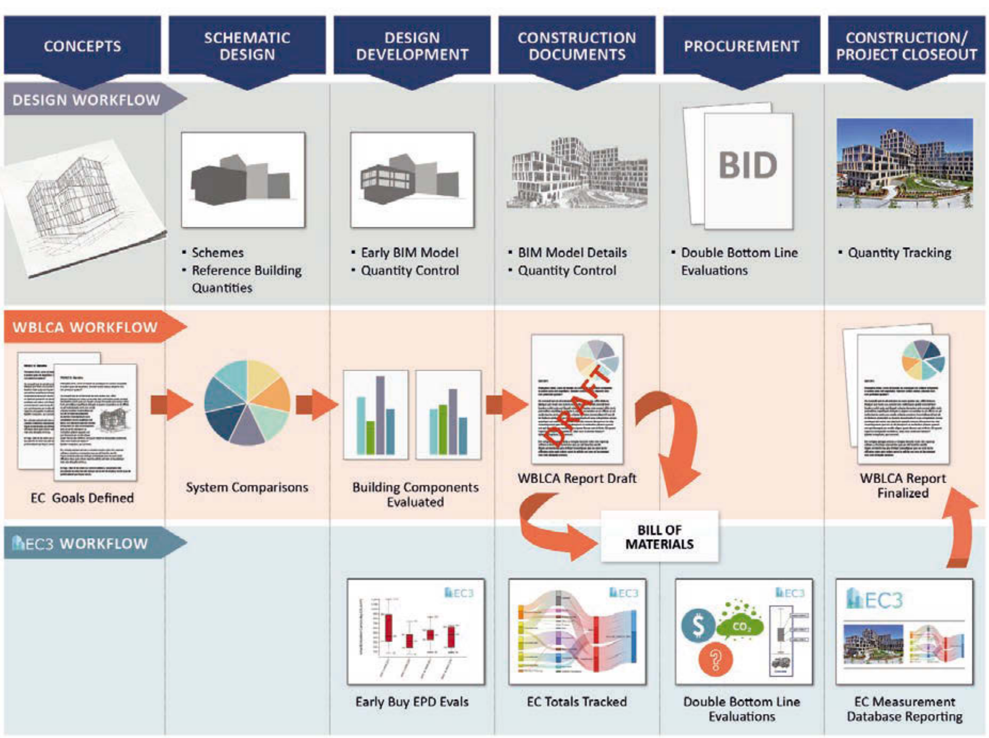
'I joined the University of Washington to teach architecture to architectural students along with the basics of construction management and structural engineering, so my students can engage with other professions and do good work. It's what I wished I'd known when I started out,' she says

'When I was practising as an engineer, it was easy to think that architects were clueless and discombobulated and engineers were on top of it, solving clear problems. Then, as an architect, I realised how many different and complex drivers are happening during the creation of a building and how hard it was to be focused. Engineers concentrate on their particular specialities, architects on everything,' she says.

'That's why, when I ran my own architectural practice, I hired a consultant structural engineer. I found it difficult to wear all the hats. If I was dealing with the client and how they wanted their rooms to look, I needed an engineer to make sure everything was structurally safe.'

↑FIGURE 2: CLF lifecycle analysis process

↙FIGURE 3: EC3 tool flowchart



CLF/DON DAVIES

STRUCTURAL ENGINEERS DECLARE

The Institution of Structural Engineers is encouraging companies to sign up to action to help the UK government hit its 2050 zero-carbon target. This is a starting point, and over the coming months the Institution will provide guidance and support to members through sharing of best practice and CPD. Key targets are to:

- →| raise awareness of the urgent need for action with clients, collaborators and supply chains
- →| advocate for faster change
- →| establish climate and biodiversity mitigation principles as a key measure of industry's success through awards, prizes and listings
- →| share knowledge and research on an open-source basis
- →| evaluate all new projects against the aspiration to contribute positively to mitigate climate breakdown and encourage clients to adopt this approach
- →| upgrade existing buildings for extended use as a more carbon-efficient alternative to demolition and new build
- →| include lifecycle costing, whole-life carbon modelling and post-occupancy evaluation as part of the basic scope of work
- →| adopt design practices to achieve the standard of net zero carbon
- →| collaborate with clients, architects, engineers and contractors to further reduce construction waste
- →| accelerate the shift to low-embodied-carbon materials in all work
- →| minimise wasteful use of resources in structural engineering design.

Sign the declaration at http://structuralengineersdeclare.com

Understanding embodied carbon

Along with the teaching at Washington, Simonen has been able to carry out research work on the material carbon impact of structures using environmental lifecycle assessment **(Figure 2)**. At the same time as she joined the academic world a decade ago, she had also united with likeminded professionals with whom she launched the CLF.

A recent success was the creation of the free Embodied Carbon in Construction Calculator (EC3) tool, which helps provide the answers to the questions that Simonen was asking 15 years ago. Now sponsored by over 50 organisations, it gives users a way to estimate the embodied carbon of different types of structural assemblies and materials with data gathered from publicly available manufacturer-specific environmental product declarations **(Figures 3 and 4)**.

'Steel, concrete and wood organisations have all cooperated on this with us, which shows the value they see in it,' Simonen says.

Local success

There has been a particular opportunity for emphasis on embodied carbon in Simonen's region of the USA over the last two or three years. 'We've got a pretty clean electricity grid and good operational efficiencies in buildings, so the focus now is very much on reducing the big chunk of upfront carbon that is sunk into buildings right at the start. And structural engineers have to figure that out, that is the part they are responsible for.'

It has been encouraging and amazing to see the change in enthusiasm for low carbon in the structural engineering profession over the last three years, Simonen says. 'We started as a bunch of geeks, with one or two engineers in different firms connecting and communicating ideas that the CLF could curate. Now there is great general awareness and the adoption of a zero target for 2050 by the SEI in the USA and the IStructE in the UK has given a huge boost to our work on reducing embodied carbon in structures.'

An early highlight for the CLF was convening a group of people to create the rules to estimate the environmental footprint of concrete mixes reported in environmental product declarations. 'It is a unique product depending on how you source the materials and make it,' says Simonen. 'You need to understand the choices you make.'

That information fed into the EC3 tool and in turn found itself being critical to the building codes of Marin County in northern California, which now set the limits of acceptable concrete in carbon using the CLF data. 'I'm excited by data that tells me what I want to know and lets policy-makers see this sort of thing is possible,' she says.

HAVE YOUR SAY

tse@istructe.org

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One step at a time

The CLF now has members in 59 countries and 586 cities, including London, Hong Kong and Cairo. During Covid-19, in-person workshops that would have been open to limited numbers are attracting participation from around the world, helping spread the message. These Zoom-style meetings are having benefits in other ways, Simonen says, not least in engineers' ability to communicate their low-carbon message.

'The more people get comfortable on screen, the more they are developing their skill to be able to communicate. And when you share your image, everyone gets a better sense of the person, you feel you know them and it's much better than an email or even a phone call. That all adds to the sense of community and impetus to change.'

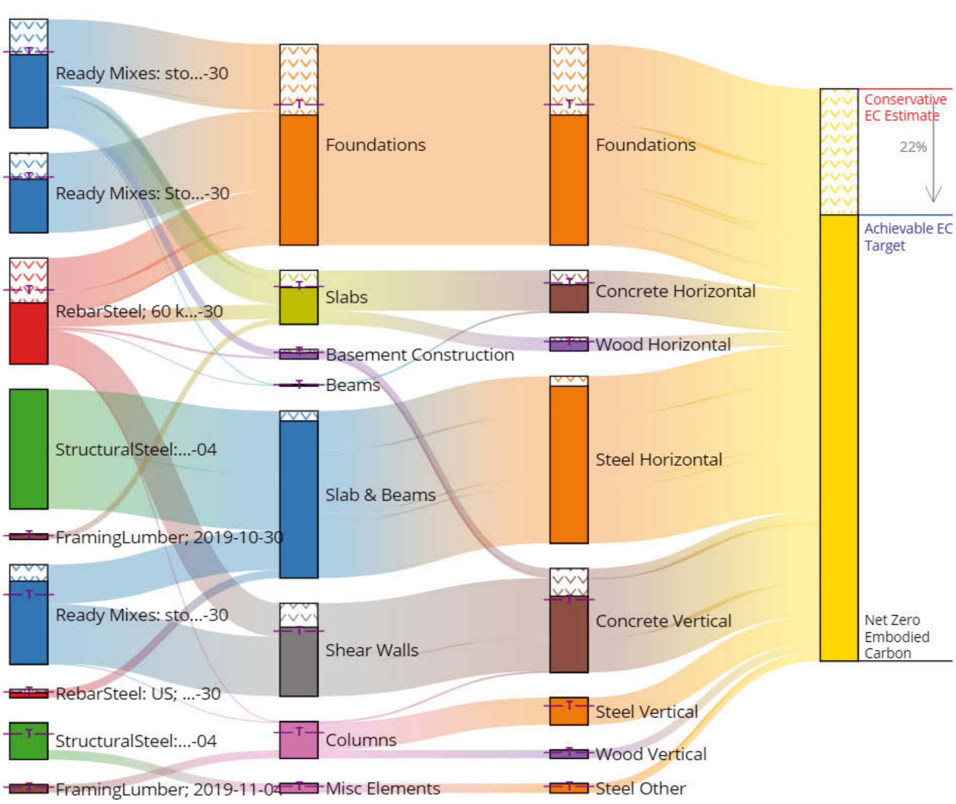
To get to zero embodied carbon in structures is not something that can happen overnight, Simonen cautions. 'We can't do it linearly, and we can't say we won't use steel and cement again. So the action to take now is to use material more efficiently, by basically doing your job really well.

'If engineers can get architects to understand that the shape of a building, for instance, has an impact on the embodied carbon because of the amount or type of material needed, that is one big step. Then they need to work together to get a more materially efficient structure. Then we are on our way to zero embodied carbon.

'Simultaneously, we all need to focus on where we get our materials from and, in the process, drive the market to incentivise investment to produce new materials that meet our demand for zero carbon.

'There are lower-carbon options on the market today. If one engineer is continually signalling they want to use them, over time they can influence clients, architects and manufacturers. That is how we will make the difference.'

FIGURE 4: EC3 tool Sankey diagram



CLF/EC3 TOOL

CARBON LEADERSHIP FORUM

http://carbonleadershipforum.org/

USE THE EC3 TOOL

www.buildingtransparency.org/