Building design and climate change

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Sustainability has long been an integral part of a structural engineer's process in building design, be that adhering to the (limited) parameters we can influence in whichever set of targets might apply – BREEAM, LEED, EcoHomes, and so on – to understanding the relative merits of typical materials and advocating for the 'least damaging' option. The IStructE include a knowledge of the environment as one of the objectives all engineers wishing to be chartered professionals must satisfy. With the structure responsible for up to 50% of the embodied carbon of a given development, it makes sense that we as engineers should appreciate and be able to consider the comparative carbon footprint of the solutions we develop.

But as climate change continues to dominate both headlines and agendas across all kinds of built environment stakeholders from the government to private developers, the industry is looking to itself to identify ways in which common practices might help tackle the climate emergency. The IStructE has setup the Structural Engineers declaration[1], inviting structural engineering professionals and firms to consider the climate emergency and join the collective effort to achieve net zero carbon emission in the UK by 2050.

Here are four ways explored or championed by the engineering community.

Stop Demolishing Existing Stock

"Reduce, Re-use, Recycle" is surprisingly applicable to entities as large as buildings. While the construction industry can and has concentrated on these as they apply to individual materials (demolition waste, steel production byproducts), there has been a renewed focus on reuse of existing building stock that has the potential for a greater impact. One of the authors of a report[2] steered by the Royal Academy of Engineering released earlier this year said "Our biggest failure is that we build buildings, then we knock them down and throw them away. We must stop doing this." That report added its voice to the Architects' Journal RetroFirst[3] and the RICS, both of whom in 2020 called for a reduction in demolition because of the huge amounts of carbon emitted during construction of new builds. That was estimated by the RICS to be up to 35% of the building's total lifecycle carbon for typical new offices (51% for residential), and has been shown to dwarf the carbon savings presented by building a new energy efficient equivalent (the carbon debt payback period being 'decades' that we potentially do not have).

Figures like that demonstrate the potential impact of reusing even some of an existing building, from foundations to facades. Maximising the use of existing building and infrastructure stock, or even keeping an open mind as to how far an existing building can be adapted to suit current purposes, will reduce the need for new construction, with all the embodied carbon that entails.

Several leading bodies within the construction industry have published guidance on the recycle or reuse of materials. For instance, the Steel Construction Institute has published relevant guidance[4] in structural steel

[1] https://www.structuralengineersdeclare.com/
[2] Decarbonising construction: building a new net zero industry, link: https://www.raeng.org.uk/publications/reports/decarbonising-construction-building-a-new-net-zero
[3] https://www.architectsjournal.co.uk/news/introducing-retrofirst-a-new-aj-campaign-championing-reuse-in-the-built-environment
[4] SCI Publication P427 Structural Steel Reuse, 2019

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reuse. Likewise the Concrete Centre has published guidance[5] on material efficiency, reuse and so on.

Enhance Efficiency
Our structural design codes are compiled so as to ensure the adequate safety of structures, with significant margins (for understandable reasons!); our design process is often streamlined to save time, ensure repetition and conformity, and in combining the two to save cost. This can add up to thousands of tons of redundancy being built into structures. Design efficiency can take many forms, from choosing to design each individual element (as opposed to one 'worst case' that can be applied to all similar entities, a practice all structural engineers will be familiar with), to looking more carefully at or revisiting the load assumptions made at earlier design stages and seeing where savings in material could be made. At the extreme, engineers are debating whether and where the current prescribed loading and safety factors might be reduced so that efficient and sustainable design is compatible with safety. Debate rages on, as seen in the recent pages of the Structural Engineer.

"With construction still responsible for 39% of the world's carbon emissions, there is a long way to go"

Consider Embodied Carbon
The IStructE in response to the climate emergency and promotion of net zero carbon design, published in August 2020 guidance6 for calculating - and minimizing - the embodied carbon in construction projects. The guidance also points to alternative concepts of achieving a sustainable design for example use of local stock of materials where possible to reduce emissions from transportation, use of sustainable concrete mixes with cement replacement products leading to reduced cement content and respective carbon emissions, use of materials with reduced embodied carbon such as timber etc.

This is becoming a key part of the design process as an increasing number of engineering consultants commit to contribute to the goal of achieving net zero carbon emission in the UK by 2050. Further details can be found in this link: https://www.istructe.org/resources/guidance/how-to-calculate-embodied-carbon/

Use BIM
By no means considered new anymore, Building Information Modelling or BIM is now the standard across many large infrastructure projects. The ways BIM can contribute to sustainable construction are remarkable and ever more innovative. As a designer, the advantages of BIM in allowing design changes to be accommodated quickly, fluidly, and with full visibility across the design team are clear: with the process of change made easier and more reliable, efficiencies and improvements are more likely to be made. Clash detection and improved design coordination minimizes later changes, reducing material use, and can reduce over-ordering. BIM can also make easier the process of retrofitting or reusing existing building stock, which has huge benefits to the environment already discussed.

Further than that, BIM over the lifecycle of a building can contribute hugely to reducing carbon footprint. Provision of BIM models in place of as built information gives owners and operators greater flexibility and ability to continuously monitor performance and make adjustments. Technologies like

[5] Material Efficiency, Concrete Centre, 2018
[6] How to calculate embodied carbon, IStructE, version 1.0 August 2020

Digital Twin even enable measurement and testing of maintenance strategies in advance, again driving efficiency.

These are just three examples of how the fundamentals of design are changing or at least being questioned, in order to contribute to the tackling of climate change. With construction still responsible for 39% of the world's carbon emissions, there is a long way to go but the industry is ambitious: the World Green Building Council has set out a vision for 100% net zero emissions buildings by 2050 and a 40% reduction in embodied carbon emissions. Go to New report: the building and construction sector can reach net zero carbon emissions by 2050 | World Green Building Council (worldgbc.org) for more information.

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