Extended abstract: A Streamlined Assessment of Whole Life Embodied Carbon in The Valentine, Gants Hill, Redbridge, UK & Ten Degrees, George Street, Croydon, UK

A study conducted for Vision Modular Systems UK Ltd

Study authors

Dr Tim Forman

Senior Research Associate & Senior Teaching Associate, University of Cambridge

Prof Francesco Pomponi

Professor of Sustainability Science, *Edinburgh Napier University*

Dr Ruth Saint

Director and Principal, *Building Research Solutions Ltd*

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Background

The construction and operation of buildings accounts for nearly 40% of global carbon emissions annually. As the construction sector pursues challenging decarbonisation goals, reductions in energy demand and carbon intensity must be made at every 'life cycle stage' of buildings and assets.

There is growing recognition of the importance of 'upfront carbon' (or the carbon associated with the production of buildings, including the making and transporting of building materials and the construction process) and on 'embodied carbon' (which includes upfront carbon and the carbon associated with use and the end-of-life stages of a building) as equal to the importance of reducing operational carbon (associated solely with the energy consumed in operating a building). As operational carbon declines with improvements in energy efficiency and greening the supply of energy, it becomes increasingly important to reduce embodied carbon. To do so requires detailed understanding of the global warming potential, or 'carbon footprint', of buildings over their whole life. Nevertheless, a majority of life cycle assessment (LCA) studies include evaluations based on design- stage assessment – often including numerous large assumptions – while comparatively few studies of as-built constructions are available. This study deals with the latter and provides a post-construction whole life embodied carbon assessment of two buildings: The Valentine and Ten Degrees.

Study Details

This study was conducted in 2021 to assess the carbon footprint, or 'whole life embodied carbon', of two distinct buildings completed in the UK in 2020 by Tide Construction, using Vision Modular Systems volumetric modules:

- The Valentine in Gants Hill in the London Borough of Redbridge, a brick-clad 333-bed student accommodation scheme over 10 storeys; and
- Ten Degrees in George Street in the London Borough of Croydon, comprising two terracotta- clad towers of 44 and 38 storeys providing a total of 546 homes.

Tide Construction is an industry-leading property developer and contractor, specialising in both traditional and volumetric construction. Its accredited 3D volumetric company, Vision, provides solutions for housing, build-to-rent, student accommodation, and hotels at scale and at pace.

The assessment was conducted by a team of academic experts in accordance with the latest carbon assessment guidelines and analysis was based on actual post-construction data, conservative assumptions and a careful selection of other data inputs.

Assessment of whole life embodied carbon was based on as-built information to evaluate the carbon dioxide equivalent (CO_2e) emissions per square metre across building life cycles (Stages A, B, and C), but excluding carbon associated with operational energy. Assessment was conducted following a streamlined (or 'outline') LCA methodology and in compliance with guidance provided by the international standards BS EN 14044:2006, BS EN 15978:2011, and BS EN ISO 14040:2006, and the Professional Statement on 'Whole life carbon assessment for the built environment', produced by the Royal Institution of Chartered Surveyors. Results were subsequently compared to industry embodied carbon benchmarks set by the Royal Institute of British Architects ('RIBA') and the London Energy Transformation Initiative ('LETI').

Analysis was based on material quantities (kilograms, cubic metres or square metres) and transport distances (kilometres) associated with the construction of the two buildings, including their below podium elements (which were largely traditional construction), above podium elements and modular units. Analysis was based on data describing the buildings' as-built conditions (post-construction) provided by Tide and Vision and from estimated values and assumptions derived from careful evaluation of published scientific literature, internationally accepted LCA databases and from Environmental Product Declarations (EPDs). Assessment was based on a single assessment and did not include uncertainty analysis.

The study was commissioned by Tide Construction Ltd and Vision Modular Systems UK Ltd, with coordination provided by HTA Design LLP.

Findings

The LCA study produced estimated whole life embodied carbon values for the Valentine in Gants Hill and Ten Degrees in George Street buildings of 552 kgCO2e/m2 and 717 kgCO2e/m2, respectively.

Based on this analysis, the whole life embodied carbon values for the Valentine in Gants Hill and Ten Degrees in George Street buildings compare favourably to carbon targets set by the Royal Institute of British Architects (RIBA) and the London Energy Transformation Initiative (LETI), with values for both buildings below the RIBA 2025 and LETI Band C benchmarks, and values for the Valentine in Gants Hill building below RIBA 2030 and LETI Band B benchmarks. Respectively, values for the Valentine in Gants Hill and Ten Degrees in George Street buildings were 40% and 54% lower than the RIBA 'business as usual' benchmark and LETI Band E benchmark.

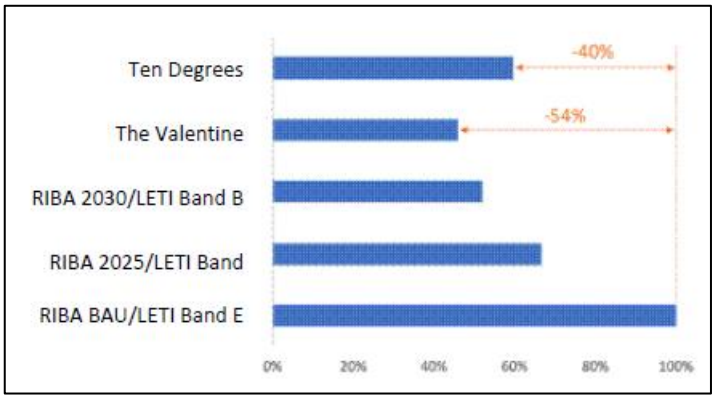

Figure 1: Comparison of whole life embodied carbon values produced for Ten Degrees and The Valentine (as constructed by Tide) against RIBA and LETI benchmark carbon targets. NB: Values are based on single assessment using reported methodology.

Based on the study methodology, significant differences in contribution to whole life embodied carbon associated with various construction elements were indicated. The vast majority of whole life embodied carbon (which as described above does not reflect a building's operational energy use) was associated with the production stages (A1-A3) that precede the construction and later life stages. Production (including raw material supply, transport and manufacturing in the product stage) represented approximately 87% of The Valentine and 85% of the Ten Degrees buildings' whole life embodied carbon, with construction stages (A4-A5) representing less than 3% and 1%, respectively.

In both buildings, the largest share of total project carbon from the earliest life cycle stages to construction completion (A1- A5) was associated with modules; these stages accounted for nearly one half (48% and 49%, respectively) of total project carbon. We note that modular components account for 80% of floor area in the Ten Degrees building and 88% of floor area in The Valentine. Below podium elements and above podium elements were associated with 21% and 31% of carbon across the two projects. Carbon intensity in these lifecycle stages (A1-A5) in modules is primarily associated with structural steel sections (53% and 59%); while in below podium elements it was primarily associated with steel reinforcement bars (39% and 42%) and substructure, superstructure

and piling (a combined 42% and 50%); and in above podium elements, it was predominantly associated with cladding panels (41% and 48%).

Conclusion

This assessment found whole life embodied carbon values for the Ten Degrees building and The Valentine, as constructed by Tide, compared favourably to industry benchmarks and targets established by RIBA and LETI. Study findings suggest that construction projects in analagous contexts may significantly reduce whole life embodied carbon by using similar approaches to design and construction instead of traditional reinforced concrete construction methods. This study contributes to deepening evidence and assessment of the whole life embodied carbon of buildings, and it suggests that significant reductions against 'business as usual' can be achieved in pre-operation stages (i.e., all stages up to completion of construction), as evidenced by the Ten Degrees and The Valentine buildings.