EXECUTIVE SUMMARY

Ridge and Partners LLP have been appointed by Salboy Ltd to undertake an Embodied Carbon study for the proposed new hotel and residential development 'Viadux Phase 2' in central Manchester. The study covers the proposed scheme which consists of Phase 2a (main tower and podium) and Phase 2b (smaller residential tower). The modelling results are based on Stage 2 design information and assumed material quantities where necessary to provide a best estimate of the scheme's impact at this stage. Please note the below modelling does not include emissions associated with operational energy or water, as this is not within an embodied carbon scope.

All available information was collected from the team to form the most accurate picture of the proposed scheme as possible, however it is acknowledged that some elements for Phase 2 rely on more detailed information being developed by the team during the upcoming design stages, particularly in relation to the hotel. The headline results are reported below:

Table 1. Upfront Carbon totals.

	Embodied Carbon (Modules A1-A5, B1-B4 & C1-C4)	
	tCO_2eq	**$kgCO_2eq/m^2$ GIFA**
Phase 2 Total (91,860m^2)	**76,779**	**836**

To put the above results into context, the scheme is currently located within Band D of the RIBA Embodied Carbon rating scale, narrowly exceeding the RIBA 2025 Target for residential buildings by 3,291 tCO_2eq (equivalent to 36$kgCO_2/m^2$, which would be a 4.3% reduction against the current total).

Interrogating the reported carbon totals further, the figure below sets out the upfront (i.e. construction) and embodied (i.e. 60-year lifetime) carbon impacts in tCO_2eq for each of the key building elements.

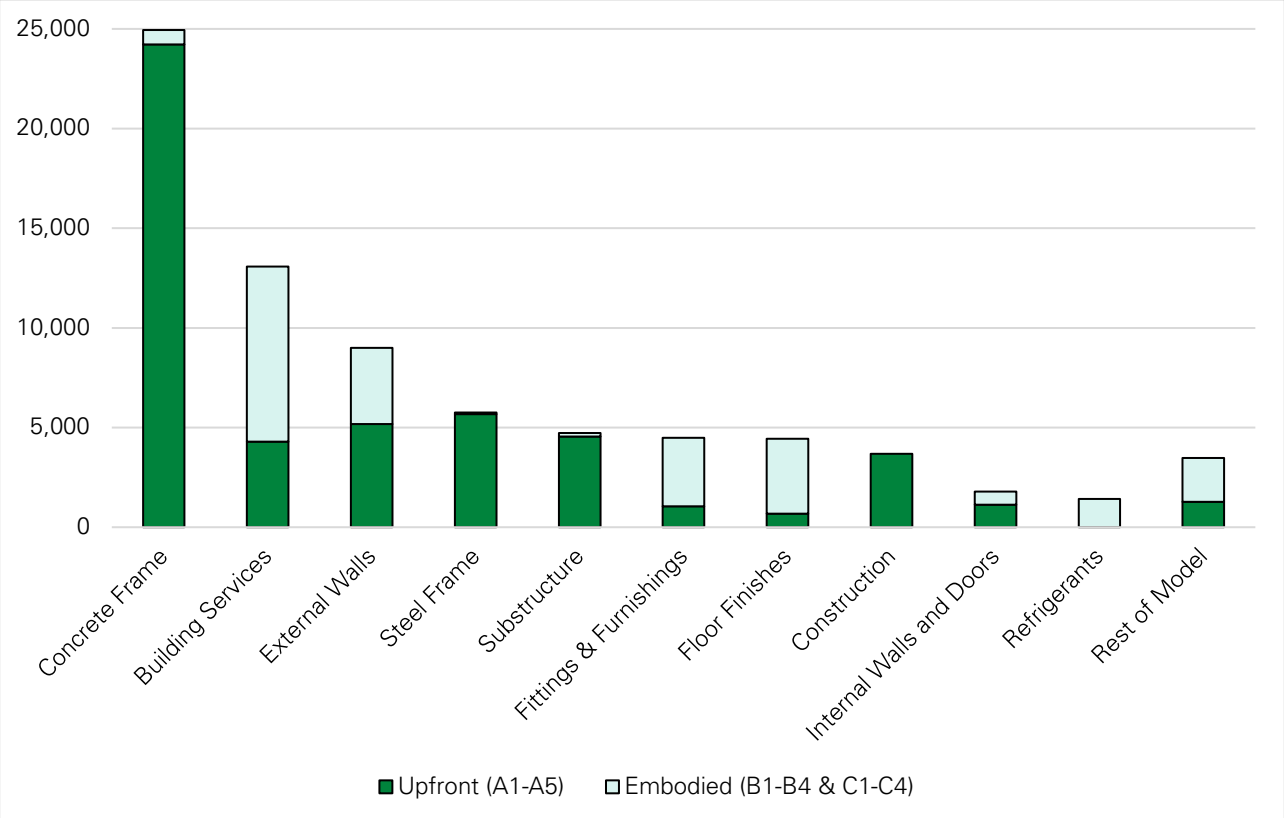


Figure 1. Embodied Carbon by key elemental impacts

Given the high-rise nature of the scheme and the abnormal challenges associated with constructing around and above the existing Grade II listed Castlefield Viaduct, the structural solution on the scheme is significant. As such, the Concrete Frames are the most significant material impact across the scheme by some margin, with 32% of the total embodied carbon impact attributed to reinforced concrete columns, core walls and floor slabs. In addition to the significant structural solution, the result is also influenced by the high carbon intensity of cement production (which is used within the concrete).

Likewise, the significant coverage of external wall glazing, internal furnishings and building services result in significant contributions to the embodied carbon total. The breakdown between upfront and subsequent embodied carbon impacts also highlights which elements have an impact predominantly associated with the initial material and construction (e.g. concrete frame, steel frame, substructure) and which elements have a more staggered impact associated with lifetime replacements (e.g. building services, fittings and furnishings, floor finishes).

POSSIBLE MITIGATION MEASURES

The most efficient method of reducing carbon emissions is to build less and reuse existing products and materials, however, this is not always possible due to availability or building performance requirements. Therefore, the next step is often to look for lower carbon alternatives within the materials commonly used and to prioritise efficiency.

Cement

Concrete is one of the most carbon intensive materials used in construction and this is largely attributable to the Portland Cement within, which has a very energy intensive production process. Long term, concrete manufacturers need to bring down the impacts associated with cement to help decarbonise construction, but in the short-term replacing cement with functionally equivalent alternatives can help to achieve notable savings.



Figure 2. Pour of concrete slab. Where cement replacement and minimisation practices are implemented the carbon impact associated with concrete elements can be notably reduced.

Fly Ash (PFA) and Ground Granulated Blast Furnace Slag (GGBS) are two examples of commercially available cement replacement products which are both by-products of heavy industry (iron-making blast furnaces for GGBS, and coal-burning power plants for PFA). In both cases, their carbon impact is comparatively lower than Portland Cement, and therefore their partial usage helps to reduce reliance on more high-carbon material. In the case of this study, allowances have been made for the minimum cement replacement rates to the Raft Foundations and Lower Structural Columns based on information provided by the structural engineer

Renaissance Ltd, however higher proportions of cement replacement could potentially be incorporated subject to review of the impact on concrete curing times and their availability at the time of procurement.

At present, GGBS is increasingly being specified on developments as a means of reducing the embodied carbon impact of concrete, so much so that GGBS is transitioning away from being a underutilised by-product and instead is now in high commercial demand for the sustainability benefits and other unique technical properties. At the same time, the heavy industry processes that produce these by-products are slowly being phased out in the UK (with blast furnaces being replaced by electric arc furnaces for steel production, and coal fired power stations being decommissioned). As a result, the subsequent embodied carbon impact of GGBS / PFA is expected to increase over the coming years. Additionally, the UK standard for concrete specification (BS8500) is in the process of being updated to provide further opportunities for cement replacement through the use of materials such as Limestone Calcined Clay Cements (LC^3) at higher than previously allowed rates, again offering a route to lowering the embodied carbon impact of concrete.

Transportation of Products and Site Construction Impacts

In addition to using industry average material quantities (where estimations are unavailable at the early design stage), the modelling software also relies on default transport distances (Module A4) which are currently included in line with RICS Whole Life Carbon guidance. These impacts are assigned to each element individually, so the reported values for each building element include a proportion of transport impact within them. Typically, the A4 impacts contribute ~10% of the upfront carbon total, so interrogating and improving upon the default transport distances allowed for currently by procuring construction materials and products locally could lead to a notable saving in the carbon total.

Construction site impacts (Module A5), meanwhile, are calculated and applied across the development generally, rather than against individual elements, based on best practice guidance from the Building Research Establishment (BRE). These impacts form a significant part of the overall reported embodied carbon total (approximately 7%) therefore improved contractor performance over the baseline assumptions will generate a reduction in the overall upfront carbon totals. Savings could be made by targeting reductions in waste generated on site (and maximising re-use of materials), and through reduction in impact of site fuel use (lower diesel usage, replacing diesel with grid electricity / biodiesel).



Figure 3. Transport of concrete from manufacturing plant to construction site. Transport of materials to site typically accounts for around a tenth of the total upfront carbon impact (A1-A5).

ASSUMPTIONS AND LIMITATIONS

To further supplement the information provided by the design team, certain assumptions have been made. These are based on reasonable industry standards and on our experience with similar building projects. These assumptions were verified with the design team / client team, and are listed below:

- Due to the early stage of modelling, a project cost plan was not made available to verify that 95% of the cost of each major element (e.g., substructure, superstructure) is included in the modelling, in line with RICS 'Whole Life Carbon' guidance. However, the information provided by each of the key design team members (architectural, structural, civil, MEP) has covered the full scope of works for the Phase 2 scheme. No 'in scope' items have been knowingly excluded from the model.

- Transport impacts (Module A4) have been included in line with the RICS Whole Life Carbon guidance. No specific product transport details have been included, as procurement has not been defined at this early stage.

- Construction impacts (Module A5) have been included in line with assumed fuel usage and waste production values across the full construction period of the project as follows:
    - Site Waste: 6.5t per 100m^2 gross internal area based on BRE good practice site waste guidance.
    - Site Energy Use: 23.58 kWh; 1.12 l diesel and 0.05l petrol all per m^2 gross floor area (based research conducted on construction site operations in temperate climatic regions, provided by One Click LCA software).

- Impacts have been considered to commence on the existing Viadux site, therefore, works associated with site preparation are expected to be inconsequential.

- For concrete specifications, information provided by Renaissance Ltd for the likely strength, reinforcement and cement replacement rates have been used.

- For the external facades, EPDs from Kawneer curtain walling have been used as these have been indicated to be the likely product and manufacturer for the scheme.

- At this stage, high level allowances for mechanical & electrical installations have been made based on information provided by the design team, using a 'typical' apartment as reference to extrapolate across the residential aspect of the scheme. For the hotel, a 'typical' services package for hotel, common area and building-wide systems has been used.

- Information provided by the design team has been used to account for finishes, sanitaryware, fittings and furnishings across the scheme. Non-fixed fittings, furnishings and equipment have been excluded from the assessment scope.

- Where no EPD information or specific product references have been provided, generic UK EPDs have been selected matching the closest description to the materials detailed on the documents provided, with assumed recycled contents aligning with RICS Whole Life Carbon Guidance.

- Module B1 (Emissions in Use) has been accounted for using values for refrigerant charge provided by the design team. R32 and R1234ze have been included as the operational refrigerant types and annual / end-of life have been assumed as 2% and 1% respectively for package systems, and 6% and 3% respectively for VRF systems, in line with TM65 guidance

- Modules B2 (Maintenance) and B3 (Repair) have been assumed at 10 $kgCO_2eq/m^2$ GIFA and 2.5 $kgCO_2eq/m^2$ GIFA respectively, in accordance with GLA Whole Life carbon assessment methodology (London Plan Guidance: Whole Life Carbon Assessments).

- Module B4 (Replacement) has been incorporated in the form of default product service lives for each material, based on RICS Whole Life Carbon guidance. For example, unitised curtainwalling systems and internal finishes have an assumed expected lifespan of 35 years and 10 years respectively. It is worth noting that the modelled Module B4 emissions do not account for future decarbonisation of the grid and the subsequent benefit this would have on the carbon intensity of product manufacture in the future.

- Module C1 (Deconstruction / Demolition) has been assumed based on UK average demolition impacts relative to gross floor area, as provided by RICS / One Click LCA software.

- Modules C2-C4 (Waste Transportation, Waste Processing & Waste Disposal) are assumed based on end-of-life processing chains relative to each material, as provided by One Click LCA software.