HARRINGTON SQUARE, CAMDEN

SUSTAINABILITY REPORT

STRUCTURAL & CIVIL ENGINEERING

Project No 2202-03

June 2023

Rev: P02

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P01	Sustainability Report - Draft	RLC	EM	21.06.2023
P02	Stage 2	RLC	EM	05.09.2023

1.0 SUSTAINABILITY

1.1 Overview

The aim of this assessment is to estimate the Upfront Embodied Carbon and Whole Life-Cycle Embodied Carbon for the structural elements of the proposed development. This includes the Embodied Carbon associated with the extraction of materials, manufacture, transportation, and construction. It also includes for the ongoing maintenance, repair, and replacement during occupation as well as dismantling, demolition, and eventual material disposal.

For the assessment of the Whole Life-Cycle Carbon for the development, including the operational carbon and carbon associated with non-structural items, including architectural elements (façade, partitioning etc.) and building services elements (plant, cabling, ducting etc.), reference should be made to other consultants' reports. This assessment and data can be provided to the Sustainability Advisor upon request for review and incorporation into the Whole Life Carbon Assessment if commissioned by the Client.

The assessment has been undertaken through RIBA Stage 2 and is based on the adoption of 'standard' carbon factors. Opportunities for further carbon savings are also presented and to be considered as the design develops through RIBA Stage 3 (Spatial Coordination). Consideration is also given to designing for a Circular Economy where materials are retained in use at their highest value for as long as possible and are then reused or recycled, leaving the minimum of residual waste.

It is recommended that the assessment is reviewed at RIBA Stage 3 (Spatial Coordination), RIBA Stage 4 (Technical Design) and RIBA Stage 5 (Construction) to reflect developments within the design and to incorporate more accurate site-specific carbon factors, where Environmental Performance Declarations are available.

The calculations within this assessment are sensitive to the assumptions made and the methodology adopted. These are presented within the report to allow for comparison where required.

1.1.1 Whole Life Carbon Background Assessment

The climate change emergency is a global issue with countries taking varying levels of action. Through the Climate Change Act Amendment 2019, the UK Government has committed to 'Reduce UK Greenhouse Gas Emissions by at least 100% (against 1990 levels) by 2050'.

Building Regulations Part Z will mandate whole life carbon assessment for developments above a defined scale and set limits on embodied carbon. Based on the current draft, assessment of the Upfront Embodied Carbon and Whole Life Carbon will be required prior to commencement of works, and upon completion to demonstrate that the limits are not exceeded. The assessments will need to be submitted to Building Control at both stages. The current draft does not currently include limits on embodied carbon. Part Z is also not expected to be implemented until 2025.

London Plan Guidance (LPG) for Whole Life-Cycle Carbon Assessments was issued in March 2022 and provides guidance on the assessment methodology. It also provides benchmarks for Upfront Embodied Carbon and Whole Life Carbon with aspirational benchmarks based on achieving a 40% reduction in Whole Life Carbon emissions by 2030. These benchmarks vary depending on the building typology (e.g., Office, Residential, Education and Retail).

An aligned approach on Embodied Carbon Targets has been developed by LETI, WLCN, RIBA, and The Institution of Structural Engineers. These targets provide a rating scale which can be applied to the Upfront Embodied Carbon and Life Cycle Embodied Carbon to allow for benchmarking and is based on building typology (Figure 6.01).

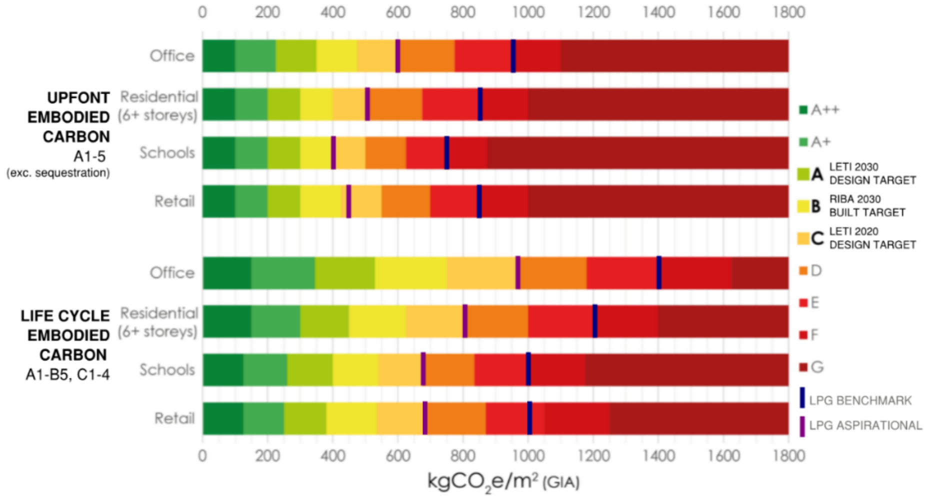


Figure 6.01 Aligned Embodied Carbon Targets

In addition to the PG and aligned targets above, The Institution of Structural Engineers has developed the Structural Carbon Rating Scheme (SCORS) to allow for benchmarking of the structural components of a development alone, and without consideration of the building typology (Figure 6.03).

LPG was also issued for Circular Economy Statements in March 2022 and provides a framework for assessing the Circular Economy potential of a project.

1.1.2 Assessment Methodology

The assessment follows the methodology in BS EN 15978:2011 'Sustainability of construction works – Assessment of environmental performance of buildings – Calculation Method' and using RICS Profession Statement 'Whole life carbon assessment for the built environment' for the calculations.

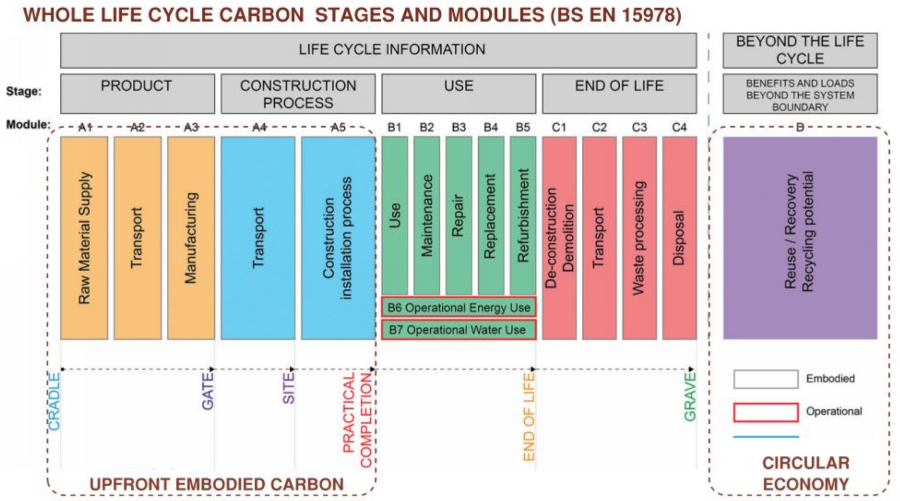
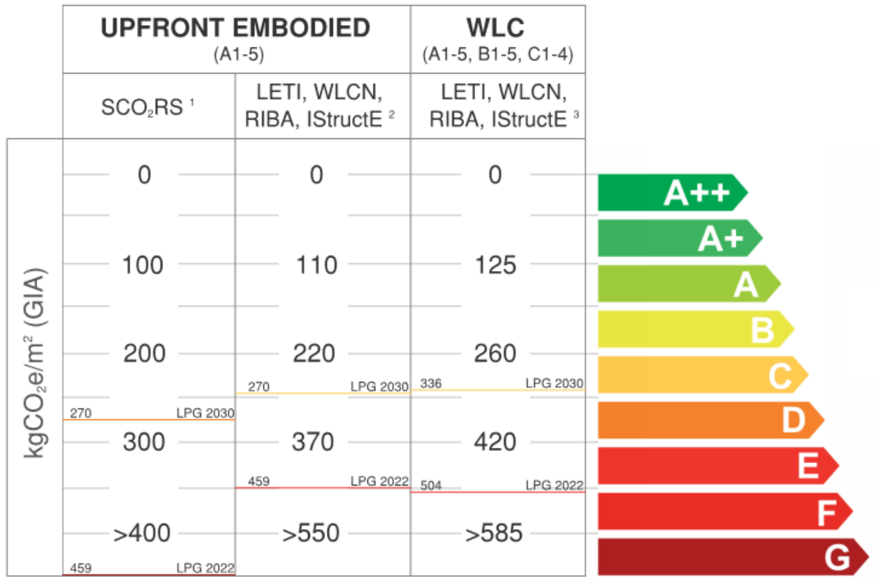


Figure 6.02 – EN 15978 Whole Life cycle Carbon Stages & Modules

For the Upfront Embodied Carbon modules A1-5 are assessed (Figure 6.02). For the Whole Life Carbon modules A1-B5 and C1-4 are assessed.

The carbon factors are extracted from the Inventory of Carbon and Energy (ICE) database V3, The IStructE 'How to calculate embodied carbon' March 2022, and project and product specific Environmental Product Declarations (EPDs) where available.

To provide benchmarking for the substructure and superstructure elements it is proposed that the SCORS, together with ratings extrapolated from the Aligned Targets are adopted. These are summarised in Figure 6.03, which also includes the extrapolated LPG benchmarks.



¹ Rating based on total A1-A5 emission for substructure and superstructure, excluding sequestration and offsetting, in accordance with the IStructE guide *How to calculate embodied carbon*
² Rating based on the substructure and superstructure accounting for 54% of the LETI, WLCN, RIBA & IStructE aligned targets for Upfront Embodied Carbon. The 54% is based on LPG and LETI guidance.
³ Rating based on the substructure and superstructure accounting for 42% of the LETI, WLCN, RIBA & IStructE of the aligned targets for Whole Life Carbon. The 42% is based on LPG guidance.

Figure 6.03 – Proposed Benchmark Ratings

1.2 Embodied Carbon Assessment

The following embodied carbon assessment has been completed on the submitted RIBA stage design for the sub and superstructure associated with the Harrington Square scheme. During Stage 2 several grid and framing options were investigated to help inform the proposed framing solution. Based on 'business as usual' assumptions on material specification and construction methodology. The Upfront Embodied Carbon (A1-5) for the chosen option is shown in Figure 6.04.

1.2.1 RIBA Stage 2 Structural Design Option 1

Using a majority steel frame with composite steel deck slabs, Option 1 shows the highest embodied carbon figure of the three options. This value however is subject to change as the design is developed, as discussed in Section 6.2.5

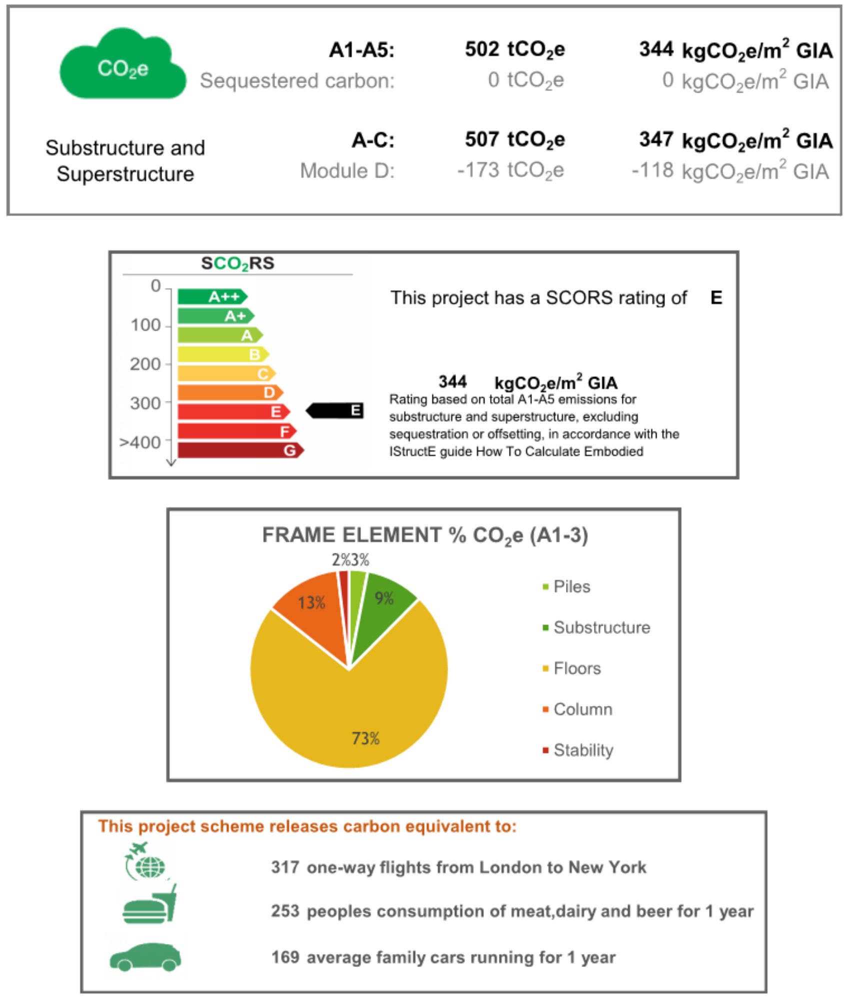


Figure 6.04 – Stage 2 Structural Design Option

1.2.2 Summary

The carbon assessment is an estimate at this stage based on generic database values which will be subject to change as further coordination occurs and site specific EPDs are obtained from the Contractor. However, they are of sufficient accuracy to understand the impact to the embodied carbon associated with a structurally efficient grid arrangement and efficient use of concrete with 25% cement replacement.

The chosen scheme will be developed to maximise structural efficiency, while delivering an arrangement that is coordinated with spatial planning constraint. The design has been developed taking cognisance to minimise material within the super and substructure to realise an arrangement with low embodied carbon.

The current Stage 2 design, with the current reinforcement estimates and concrete with 25% GGBS has an embodied carbon value of 344 $kgCO_2e/m^2$. It therefore sits between the 2022 target level for embodied carbon A1-A5 of 523 kgC02e/m², and the 2030 aspirational target of 330 kgC02e/m².

The quantum of GGBS to achieve further gains is within relatively normal levels of portland cement replacement considered for reinforced concrete mixes that would not have a significant impact on strength gain.

Elements such as the foundations could sustain a greater quantum of cement replacement, with a notional increase in curing time. This would normally be acceptable, since the foundations are not loaded to their full capacity until the frame is complete by which time the concrete has had sufficient time to cure.

The design will be developed throughout Stages 3,4 and 5 and these developments may include rationalisation of the element sizes and further savings in the embodied carbon from a material perspective.

It is also worth recognising that the calculated figures are based on the reinforcement estimates and we would expect that the final quantities to be lower on completion of the reinforcement detailing at Stage 5.

1.2.3 Stage 3-5 Carbon Saving Opportunities

As the design develops through RIBA Stage 3 and beyond, there are further opportunities to reduce the embodied carbon and the points noted below identify areas that can be targeted or considered during the next stage.

- Alter grid to standardise slab edge deflections
- Agree longer striking times
- Assess use of higher percentage GGBS within floorplates
- Reduce slab thicknesses and/or reinforcement quantities

Working with the contractor, concrete frame subcontractor and the concrete supply chain may generate further opportunities to reduce the embodied carbon through changes in construction methodologies, greater blended mixes with cement replacement and EPD's.

HARRINGTON SQUARE, CAMDEN

EMBODIED CARBON ASSESSMENT STAGE 2 DESIGN (SEQUESTRATION NOT INCLUDED, 25% GGBS CONTENT)

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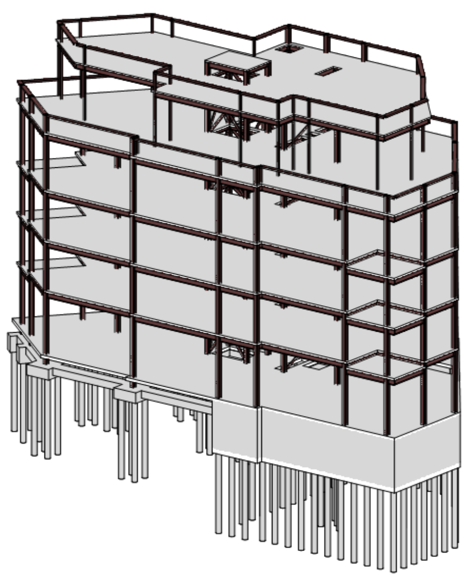
Gross Internal Area [1] = 1,460 m^2
Construction Value [2] = £3,500,000
Sub and superstructure Construction Value [3] = £1,575,000 45 %

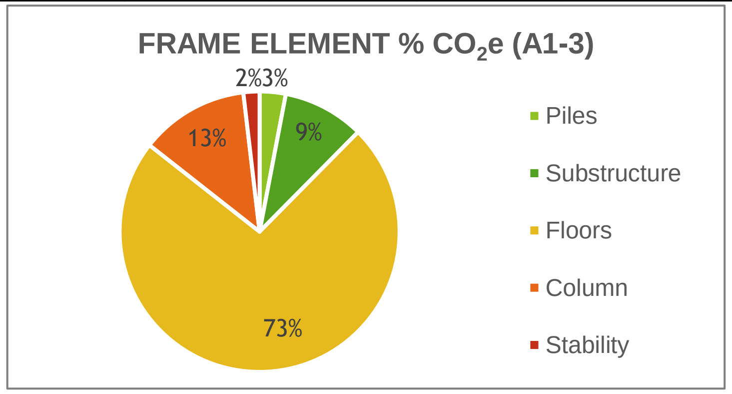
PROJECT SPECIFIC DATA

Element	Material	Material grade/type	% GGBS (Concrete)	Volume (m^3) (Revit)	Rebar Quantity (kg/m^3)	Transport To Site: Mode	Transport To Site: Dist	Waste Transport: Mode	Waste Transport: Dist	Material Weight (kg)	Rebar Weight (kg)	Material Embodied carbon: kgCO2e /kg	Material Embodied carbon: tCO_2e	Reinforcement embodied carbon: kgCO2e /kg	Reinforcement embodied carbon: tCO_2e	A1-3 tCO_2e	A4[6] tCO_2e	C2[13] tCO_2e	C3-4[14] tCO_2e	Waste Factor	A5w [8] tCO_2e	A5a [7] tCO_2e	A1-3 Sequestration value: kgCO2e /kg	A1-3 Sequestration value: tCO_2e	D [15] tCO_2e
Other element	Excavation	N/A	N/A	74	0	Road	0	Road	50	147,400	0	0.000	0	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.79	1.35	0.000	0.000	0.000
Pile(s)	Concrete	C35/45	25%	38	70	Road	25	Road	50	94,129	2,689	0.129	12	0.760	2.04	14.19	0.04	0.08	0.18	0.053	0.77	1.31	0.000	0.000	-0.1158
Pile Cap(s)	Concrete	C35/45	25%	13.7	120	Road	25	Road	50	33,467	1,639	0.129	4	0.760	1.25	5.56	0.01	0.03	0.07	0.053	0.30	0.51	0.000	0.000	-0.0412
Ground Beam(s)	Concrete	C35/45	25%	11	230	Road	25	Road	50	26,215	2,461	0.129	3	0.760	1.87	5.25	0.01	0.03	0.07	0.053	0.28	0.49	0.000	0.000	-0.0322
Other Found	Concrete	C35/45	25%	49	100	Road	25	Road	50	120,883	4,934	0.129	16	0.760	3.75	19.34	0.05	0.10	0.25	0.053	1.05	1.79	0.000	0.000	-0.1487
Other Wall(s)	Concrete	C35/45	25%	66.3	110	Road	25	Road	50	162,533	7,297	0.129	21	0.760	5.55	26.51	0.07	0.14	0.34	0.053	1.43	2.45	0.000	0.000	-0.1999
Slab(s)	Concrete	C35/45	25%	186.5	70	Road	25	Road	50	456,950	13,056	0.129	59	0.760	9.92	68.87	0.19	0.37	0.90	0.053	3.73	6.37	0.000	0.000	-0.562
Slab(s)	Concrete	C35/45	25%	64.9	150	Road	25	Road	50	158,956	9,732	0.129	21	0.760	7.40	27.90	0.07	0.15	0.36	0.053	1.51	2.58	0.000	0.000	-0.1955
Framing	Steel	Hot Section	25%	18.2	0	Road	300	Road	50	142,792	0	1.550	221	0.000	0.00	221.33	7.14	1.19	2.88	0.010	2.33	3.97	0.000	0.000	-131.37
Column(s)	Steel	Hot Section	N/A	4.9	0	Road	300	Road	50	38,151	0	1.550	59	0.000	0.00	59.13	1.91	0.32	0.77	0.010	0.62	1.06	0.000	0.000	-35.099
Bracing	Steel	Hot Section	N/A	0.7	0	Road	300	Road	50	5,652	0	1.550	9	0.000	0.00	8.76	0.28	0.05	0.11	0.010	0.09	0.16	0.000	0.000	-5.1998
Other Wall(s)	Steel	Hot Section	N/A	0.0	0	Road	300	Road	50	0	0	1.550	0	0.000	0.00	0.00	0.00	0.00	0.00	0.010	0.00	0.00	0.000	0.000	0
Roof Steel	Steel	Hot Section	N/A	0.0	0	Road	300	Road	50	0	0	1.550	0	0.000	0.00	0.00	0.00	0.00	0.00	0.010	0.00	0.00	0.000	0.000	0
Secondary Steel	Steel	Hot Section	N/A	0.0	0	Road	300	Road	50	0	0	1.550	0	0.000	0.00	0.00	0.00	0.00	0.00	0.010	0.00	0.00	0.000	0.000	0
				527						1,387,127	0		425		32	457	10	2	6		13	22		0	

STRUCTURAL FRAME - STAGE 2 - GLOBAL WARMING POTENTIAL GWP (TCO_2e)

Building Element				Product Stage A1-A3 TCO_2e	Construction Stage A4 TCO_2e	Construction Stage A5 TCO_2e	Upfront Carbon Total (A1-A5) TCO_2e	Upfront Carbon Total (A1-A5) $kgCO_2e/m^2$	Use Stage B1 [9] tCO_2e	Use Stage B2 & B3 [10] tCO_2e	Use Stage B4 & B5 [11] tCO_2e	End of Life (EoL) Stage C1 [12] tCO_2e	End of Life (EoL) Stage C2 [13] tCO_2e	End of Life (EoL) Stage C3 & C4 [14] tCO_2e	TOTAL (A to C) cradle to grave tCO2e	TOTAL (A to C) cradle to grave $kgCO_2e/m^2$	D Benefits and loads beyond EoL tCO_2e	D Benefits and loads beyond EoL $kgCO_2e/m^2$
0	Groundworks	0.4	Excavation	0	0	2.1	2	1					0.0	0.0			0.000	0.00
1	Substructure	1.1	Substructure	71	0	10.4	81	56					0.4	0.9			-0.5	-0.37
2	Superstructure	2.1	Slabs & Stairs	318	7	20.5	346	237	-8.0				1.7	4.1			-132.1	-90.50
		2.2	Columns	59	2	1.7	63	43					0.3	0.8			-35.1	-24.04
		2.3	Core/Stability System	9	0	0.2	9	6					0.0	0.1			-5.2	-3.56
		2.4	Roof Steelwork	0	0	0.0	0	0					0.0	0.0			0.0	0.00
		2.5	Secondary Steelwork	0	0	0.0	0	0					0.0	0.0			0.0	0.00
				457	10	35	**502**	**343.5**	-8	0	0	5	2	6	**507**	**347.3**	**-173.0**	**-118.5**





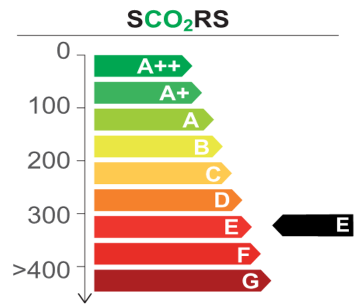
CO_2e	**A1-A5:**	**502 tCO_2e**	**344 $kgCO_2e/m^2$ GIA**
	Sequestered carbon:	0 tCO_2e	0 $kgCO_2e/m^2$ GIA
Substructure and Superstructure	**A-C:**	**507 tCO_2e**	**347 $kgCO_2e/m^2$ GIA**
	Module D:	-173 tCO_2e	-118 $kgCO_2e/m^2$ GIA

This project scheme releases carbon equivalent to:

317 one-way flights from London to New York

253 peoples consumption of meat,dairy and beer for 1 year

169 average family cars running for 1 year



This project has a SCORS rating of **E**

344 $kgCO_2e/m^2$ GIA
Rating based on total A1-A5 emissions for substructure and superstructure, excluding sequestration or offsetting, in accordance with the IStructE guide How To Calculate Embodied

NOTES & ASSUMPTIONS

1. Gross internal area to be confirmed by Architect. Excludes roof, balconies, terraces etc.
2. Construction Value to be confirmed by project Quantity Surveyor.
3. % of Construction Value associated with substructure and superstructure elements to be confirmed by project Quantity Surveyor.
4. Module A1-A3 Embodied carbon factors generally taken form the Institute for Carbon and Energy (ICE) database, V3. Concrete density taken as 2,400kg/m^3 and steel density taken as 7,850kg/m^3.
5. Module A1-A3 Reinforcement Carbon factor taken as UK CARES EPD dated 16 April 2020 for sector average.
6. Module A4 transport typically based on average distance to two nearest suppliers. Transport emissions conservatively based on the following:
   - Concrete Delivery vehicle based on a 32 tonne truck with 8m^3 capacity (19,600kg payload), with a conservative 6.7mpg (0.35l/km) fuel consumption. HM Government greenhouse gas reporting ' GHG Conversion Factors for Company Reporting' 2022 give a carbon conversion factor of 2.75kgCO_2/l for diesel. The carbon factor for a concrete delivery is therefore based on (2,750gCO_2/l x 0.35l/km)/19,600kg = 0.0491 gCO_2e/kg-km. For calculation purposed conservatively adopt 0.1074 gCO_2e/kg-km based on IStruct 2020 HTCEC
   - Reinforcement & Steelwork deliveries based on a 40T HGV laden to 50% capacity (15,000kg payload), with a conservative 8mpg (0.30l/km) fuel consumption. HM Government greenhouse gas reporting ' GHG Conversion Factors for Company Reporting' 2022 give a carbon conversion factor of 2.75kgCO_2/l for diesel. The carbon factor for a concrete delivery is therefore based on (2,750gCO_2/l x 0.30l/km)/15,000kg = 0.055 gCO_2e/kg-km. For calculation purposes conservatively adopt 0.1074 gCO_2e/kg-km based on IStruct 2020 HTCEC
   - Waste and excavation removal based on a 36 rigid vehicle with a 14m^3 capacity (28,000kg payload) loaded to average 70% capacity, with a conservative 8mpg (0.30l/km) fuel consumption. HM Government greenhouse gas reporting ' GHG Conversion Factors for Company Reporting' 2022 give a carbon conversion factor of 2.75kgCO_2/l for diesel. The carbon factor for a concrete delivery is therefore based on (2,750gCO_2/l x 0.30l/km)/19,600kg = 0.042 gCO_2e/kg-km. For calculation purposed conservatively adopt 0.1074 gCO_2e/kg-km based on IStruct 2020 HTCEC
   - Sea transport emmisions based on average cargo ship/container ship factor of 0.01614 gCO_2e/kg-km. Reference HM Government greenhouse gas reporting ' GHG Conversion Factors for Company Reporting' 2022
7. Module A5a for site activity emissions is based on RICS guide allowance of 1,400 kgCO_2e/£100,000 of construction value. This is pro-rated to reflect the substructure and superstructure costs as a percentage of the overall construction value.
8. Module A5w for material wastage is based on waste factor (WF) x (A1-3+A4+C2+C3-4), where A1-3 is the emissions for production of the wasted material, A4 is for transporting the waste to site, C2 if transporting the wasted material away from site, and C3-4 is C3 and C4 emission for processing and disposal of teh waste material.
9. Module B1 Use. As the frame is to be concrete with exposed concrete soffits an allowance of 2.5% will be allowed for reabsorption. Only the A1-A3 for the upper floor slabs will be considered for CO2e reabsorption as core walls are likely to be lined. Where ceilings may be installed as part of future fit-out works it is assumed that these will be suspended and unsealed so carbon reabsorption will occur.
10. Modules B2 and B3 Maintenance and Repair are assumed to be minimal as the frame is concrete and steel with a design life of 50 years.
11. Modules B4 Replacement and B5 Refurbishment. As the building is an office it may be subject to refurbishement during its design life. However, structural works are assumed to be minimal.
12. Module C1 Demolition and deconstruction emissions are taken as 3.4kgCO_2e/m^2 GIA in accordance with RICS guidance.
13. Module C2 for transporting waste away from site is based on the same transport emissions as Module A4, but with the distance adjust to reflect the average distance between the two nearest landfill sites to the site.
14. Module C3 and C4 are emissions for processing and disposal of waste material and are based on 0.013kgCO_2e/kg as per RICS guidance.
15. Module D end of life scenario is based on the insitu concrete, reinforcement and steel being recycled. The following UK EoL assumptions and factors have been used based on IStruct 2020 HTCEC.
    - Insitu and precast concrete 90% recycled with factor -0.00123 kgCO_2e/kg
    - Reinforcement 92% recycled with factor 0.351 kgCO_2e/kg
    - Structural Steel 85% recycled with factor -0.92 kgCO_2e/kg

    The above scenario is considered conservative as by the end of the building life the circular economy should be fully established with much of the structure reused and repurposed. Many of the processes will also be carbon neutral, resulting in minimum emissions.
16. Waste factors (WF) are based on the following:
    - Insitu 5% waste rate with a 0.053 waste factor
    - Precast concrete 1% waste rate with a 0.010 waste factor
    - Reinforcement 5% waste rate with a 0.053 waste factor
    - Structural Steel 1% waste rate with a 0.010 waste factor