Embodied CO_2e emissions due to Groundforce Shorco hire activities Technical Note

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TECHNICAL NOTE

Subject: Calculating equivalent embodied carbon dioxide (CO_2e) for Groundforce Shorco hire activities.

1.0 INTRODUCTION

Groundforce Shorco (GFS) is the market-leading rental supplier of shoring equipment in the UK, providing proprietary and bespoke shoring solutions. Our range of equipment includes:

- Site safety;
- Trench boxes;
- Trench sheets;
- Sheet and trench piles;
- Light and heavy duty hydraulic bracing;
- Mechanical and hydraulic struts.

The majority of our equipment is constructed from steel, but we do also stock some aluminium products. Equipment is maintained, repaired and stored across the UK in 17 strategically located depots. Collection and delivery of our equipment is via both external hauliers and our own fleet of transport vehicles.

GFS, part of the larger VP PLC group, acknowledges its responsibility to address sustainability. It is our aim that sustainability is universally addressed across our business activities and that we help to play our part in mitigating climate change and biodiversity loss. We hope to achieve this by minimising our environmental footprint with the goal of being net-zero by 2050 at the latest, and having a net positive impact on the environment. A copy of the VP group's sustainability report, including information on its "short term roadmap to net zero by 2050", and how we can align with the united nations' sustainability development goals (SDGs), can be found online at https://sustainability.vpplc.com/.

Through calculating the embodied CO_2e due to the manufacture (*A1 to A3*) and transport (*A4*) of our fleet, we have established a baseline value that we can use to assess the impact of our future decarbonising business plans. Furthermore, our calculations will allow us to estimate and share the embodied CO_2e of every hire, which our clients can include as part of their own carbon reporting activities, whilst also encouraging a wider conversation around reducing embodied carbon in the construction industry.

2.0 Background

2.1 Lifecycle Assessment

As per BS EN 15978, the life cycle stages of a construction project are shown in Figure 2-1 below. As a minimum, when assessing the embodied carbon as part of its lifecycle scope, modules A1 to A5 should be considered.

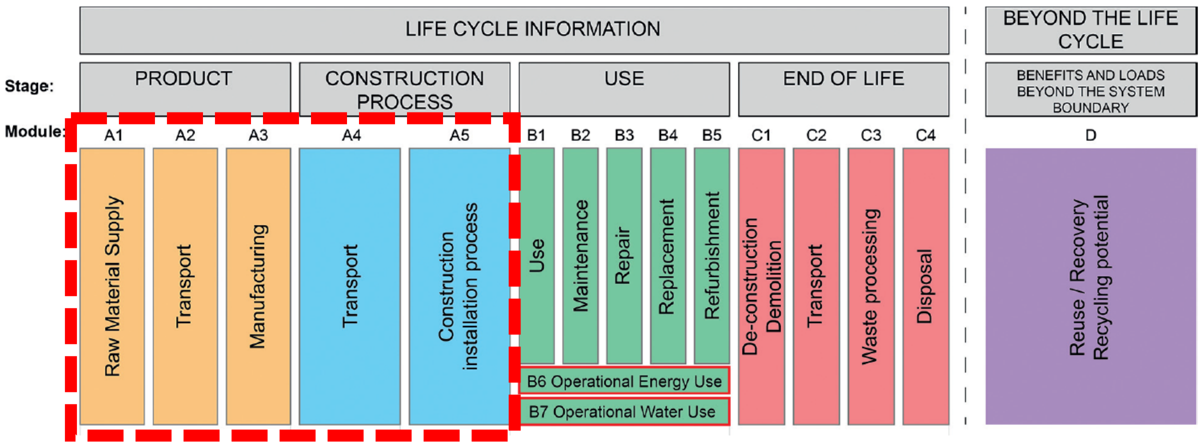

Figure 2-1 - BS EN 15978 Life cycle stages. [1]

The whole life cycle assessment is applicable to construction projects as a whole, meaning not all modules are directly applicable to temporary works (TWs) or GFS's hire activities. Through inspection, modules A1 to A4 were most aligned with GFS hire activities. Module A5 was omitted as activities relating to this module are project specific and outside of GFS's control and should be quantified by the contractor.

Modules B1 to B5, which cover the maintenance and repair of our equipment in our depots will be captured as part of a wider VP PLC carbon calculation and will not be included in the scope of this study.

The embodied CO_2e due to manufacture and fabrication of our products was apportioned out over a 10 year working life. This was considered an average lifespan across our fleet with some products lasting far beyond 10 years and others being written off earlier due to damage. At the end of its working life, our equipment is either sold or scrapped. When equipment is scrapped, we do not claim the benefit of using recycled material to make new product.

Zero waste is assumed, as 100% of the hired equipment is expected to be returned at the end of hire, except for instances where equipment is sacrificial as part of a project. To summarise, in terms of GFS hire activities, A1 to A4 cover the following activities:

- A1 to A3: Cover the material supply, fabrication of our equipment and transport to our depots prior to first use;
- A4: Covers equipment transport for delivery to, and collection from site because of hire activities.

For TWs, as per section 2.2.2.6 in IStructE's "How to Calculate Embodied Carbon" [2], the sum of emissions for A1 to A3 and A4 should be reported by our clients in module A5.

2.1.1 Modules A1 to A3 – Equipment

As per BCIS SFCA [3], the following GFS structural elements were lifecycle assessed:

- 2.1 Frames
  - Hydraulic Braces;
  - Hydraulic Struts;
  - Mechanical Struts;
  - Box Struts.
- 2.5 External Walls
  - Sheet Piles & Trench Sheets;
  - Box Plates.

We did not include the following as part of our calculation:

- 1.1 Substructure
  - Ground-bearing Slab.

Other items considered include:

- Ancillary Equipment
  - Driving Caps
  - Extractors
  - Lifting Chains
  - Gallows Brackets (Hired)
  - Quick Release Shackles (QRS)
  - Restraint Chains
- Safety Equipment
  - Edgesafe
  - Laddersafe
  - Stepsafe
- Storage
  - Stillages

Any blinding slabs, or structural slabs cast, once formation level is achieved, were not covered as part of this study and must be accounted for through the client's own carbon reporting activities.

The following equation was used to calculate the total embodied carbon for life cycle modules A1 to A3 ($kgCO_2e$):

$$EC_{A13} = \sum_{i=1}^{n} [Q_i(ECF_{A13,i})]$$

EC_{A13} = total embodied carbon for life cycle Modules A1–A3 ($kgCO_2e$)
Q_i = quantity of i^{th} material (kg)
$ECF_{A13,i}$ = Modules A1–A3 embodied carbon factor for i^{th} material ($kgCO_2e/kg$)

$ECF_{A13,i}$ factors were obtained from the IStructE's structural carbon tool [4]. It is important to determine, the origins of, and the methods by which, the steel was produced as this will affect the embodied CO_2e of the final product. Basic oxygen furnace (BOF) production of steel, powered by fossil fuels and often with low recycled material content, produces much higher CO_2e emission compared to electric arc furnaces (EAF). We have assumed our steel was produced via BOF, produced both in the UK and globally.

For the purposes of our calculations, we used the following embodied CO_2e values ($ECF_{A13,i}$) per tonne of material:

- Steel - 3.0 tCO_2e/t;
- Aluminium - Extruded Profile - 7.0 tCO_2e/t.

The steel value is an average based on a combination of both open and closed sections and includes a 20% allowance for additional emissions due to fabrication of the final product, i.e. fabrication of stiffeners, joint cassettes, welding etc.

2.1.2 Module A4 – Transport

Module A4 for transport was calculated using the following equation:

$$ECF_{A4,i} = \sum_{mode} (TD_{mode} \times TEF_{mode})$$

Where:

$ECF_{A4,i}$ = embodied carbon factor for transport to site for i^{th} material
TD_{mode} = transport distance for each transport mode considered
TEF_{mode} = transport emission factor for each transport mode considered

The transport emission factors (TEF_{mode}), were be obtained from HM Government greenhouse gas conversion factors report [5].

The report lists respective conversion factors for all major greenhouse gases for a wide range of vehicles. We focussed solely on the CO_2e emissions of averagely laden delivery vehicles.

3.0 Calculation

3.1 Equipment

As mentioned in section 2.1, we assumed a product lifespan of 10 years. As equipment hires tend to be in weekly increments, we modified the 10-year lifespan to 520 weeks. In order to ascertain the usable life of our products, we calculated their utilisation rates and apportioned out the embodied CO_2e over the products' useable life. I.e., a product with a utilisation rate of 50% would have a usable life of 260 weeks (520 x 50%).

We used historical fleet utilisation data in order to establish an average fleet utilisation (Ut_{mod}) for both steel and aluminium products, we first multiplied each individual product's utilisation (Ut) by its respective total fleet mass (Fm). We then summed these products and divided this number by the sum of all the products' fleet mass (this was done separately for steel and aluminium products).

$$Ut_{mod} = \frac{\sum_{i=1}^{N}(Ut \cdot Fm)}{\sum Fm}$$

This ensured that the total average utilisation of all products was weighted or adjusted based on its contribution towards the total fleet mass. The logic being, more mass equates to more material, and therefore higher embodied CO_2e through manufacture and fabrication.

$$EC_{A13} = \frac{ECF_{A13,i}}{520 \cdot Ut_{mod}}$$

3.2 Transport

We analysed our national transport movements within a 12-month period, taking account of both deliveries and collections. From these data, we extrapolated the following detail:

- Journey distance (km) - TD_{mode};
- Vehicle type (i.e. van, rigid HGV, articulated HGV);
- Maximum vehicle carrying capacity - M_{max};
- Shipment mass - M_{act}.

We have assumed that one vehicle was able to carry all of the hire to a particular site. If it is know that multiple vehicles will be delivering equipment, then this will need to be accounted for in the client's calculation.

We have provided two different calculation versions depending on the level of detail required by the client:

3.2.1 $ECF_{A4,i}$ - High Level (HL) Approach

The high level approach of the $ECF_{A4,i}$ calculation provides average embodied CO_2e emissions per kg of equipment per hire, irrespective of the journey distance. This equation assumes a journey distance of 96km for delivery, and 96km for collection, i.e. 192km in total (this is our average journey distance per hire). If the client's journey is substantially higher or lower than this, then it would be prudent to use the detailed level approach as outlined in section 3.2.2 below.

To calculate the below we multiplied an individual hire's journey distance by the appropriate greenhouse gas emission factor (ensuring that both a delivery and collection journey for the same hire are accounted for). We then multiplied the sum of this product by the ratio of the shipment mass to the maximum carrying capacity of the vehicle (factored by 0.75 to account for being averagely laden).

This new product was then divided by the maximum carrying capacity of the vehicle. This was repeated for individual journeys, prior to summing and calculating the average.

$$\bar{X}_{ECF_{A4,i-HL}} = \frac{\sum_{i=1}^{N} \frac{\left((TD_{mode} \cdot TEF_{mode}) \cdot \left(\frac{M_{act}}{M_{max} \cdot 0.75} \right) \right)}{M_{max}}}{N}$$

3.2.2 $ECF_{A4,i}$ - Detailed Level (DL) Approach

The detailed level approach of the $ECF_{A4,i}$ calculation provides average embodied CO_2e emissions per kg of equipment per km of journey travelled. This version will provide a more accurate estimation of transport emissions, but requires additional data and calculation.

The logic of the below equation is similar to HL approach, except the final factor is divided by the journey distance, prior to summing and calculating the average. This breaks the CO_2e emissions into per 1kg of product per km travelled.

$$\bar{X}_{ECF_{A4,i-DL}} = \frac{\sum_{i=1}^{N} \frac{\frac{\left((TD_{mode} \cdot TEF_{mode}) \cdot \left(\frac{M_{act}}{M_{max} \cdot 0.75} \right) \right)}{M_{max}}}{TD_{mode}}}{N}$$

4.0 Results

4.1 Equipment

Units = kgCO_2e per kg of material per week of hire (kgCO_2e/kg/week)

- **Steel Products = 0.0145**;
- **Aluminium Products = 0.0358**.

4.2 Transport

4.2.1 High Level (HL) approach

Units = kgCO_2e per kg of equipment per hire (kgCO_2e/kg/hire)

- **= 0.015**;

4.2.2 Detailed Level (DL) approach

Units = kgCO_2e per kg of equipment per km travelled (kgCO_2e/kg/km)

- **= 0.00016**;

5.0 Examples

5.1 <u>Example 1</u>

Using HL approach for transport

Details: 10 week hire, 7.5t steel, site 100km from depot (therefore 200km for both delivery and then collection). GFS average journey distance is 192km

- A1 to A3 – Equipment (steel)
  - 0.0145 x 7500 x 10 = 1087.50kgCO_2e

- A4 - Transport
  - 0.015 x 7500 = 112.5kgCO_2e

Total (A1 – A4) = 1200kgCO_2e for the duration of the hire.

5.2 <u>Example 2</u>

Using DL approach for transport

Details: 10 week hire, 7.5t steel, site 100km from depot

- A1 to A3 – Equipment (steel)
  - 0.0145 x 7500 x 10 = 1087.50kgCO_2e

- A4 - Transport
  - 0.00016 x (100 x 2) x 7500 = 240.0kgCO_2e

Total (A1 – A4) = 1327.5kgCO_2e for the duration of the hire.

6.0 Assumptions

- All transport vehicles are assumed averagely laden;
- Multi-drop deliveries have not been considered. Instead, it has been assumed that a delivery is from depot to site and a collection is from site to depot. Vehicles are not assumed to travel unladen;
- It is assumed that a full order will be delivered/ collected by a single vehicle. Calculations for hires that require multiple vehicles will need to be scaled accordingly;
- Fuel used in delivery vehicles is assumed to be standard diesel. We have not yet assessed the impact of using biodiesels in our fleet;
- Non-UK journeys have not been considered;
- Fabrication and modification of structural steel has been accounted for within the $ECF_{A13,i}$ factors;
- All steel is manufactured via BOF;
- All products have a 10 year or 520 week lifespan;
- Blinding slabs and structural slabs have not been accounted for and if present, must be accounted for by the client;
- Maintenance and repair of the products is not captured as part of this assessment. Instead, it has been captured as part of a wider VP PLC group assessment;
- Products are assumed to be scrapped or sold at the end of their working life;
- Zero waste is assumed as all hired equipment will be returned at the end of the hire. Only on rare occasions will waste be reportable, specifically in instances where equipment is sacrificed within a TW scheme;
- Scrapped products are not assumed to be recycled into new products.

7.0 Presentation

Our documents such as drawings, quotes and full design documents will contain a graphic similar to the below.

8.0 Bibliography

[1] British Standards Institution, BS EN 15978:2011: Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method, London: BSI, 2011.

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