mpa
Mineral Products Association
The Trade Association for the Aggregates, Asphalt, Cement, Concrete, Dimension Stone, Lime, Mortar and Industrial Sand Industries

Fact Sheet 18

# Embodied $CO_2e$ of UK cements

## 1. Introduction

The information in this fact sheet is aimed at providing embodied $CO_2$ data to inform carbon footprinting in the concrete supply chain. The fact sheet covers UK cements that conform to standards BS EN 197-1[1] and BS EN 197-5[2], and their equivalent combinations, where supplementary cementitious materials such as Ground Granulated Blastfurnace Slag (GGBS), fly ash, limestone fines and calcined clay are added at the concrete plant in accordance with the British Standard for Concrete, BS 8500-2[3].

The data is based on Global Warming Potential (GWP) values for modules A1-A3 sourced from EN 15804[4] Environmental Product Declarations (EPD) wherever possible. Where EPD information is not available other sources have been used and referenced. Where MPA is aware of multiple sources of information offering different values, these sources have also been noted.

All the values used in this fact sheet are based on "gross" emissions which means emissions associated with the use of fossil waste fuels are included.

## 2. Indicative embodied $CO_2$ of UK cements

The $CO_2e$ for UK Cements are shown in Table 1. The data in this fact sheet does not include the transport of materials to the concrete plant and this should be added by the concrete manufacturer in order to determine the $CO_2e$ for material delivered to a specific concrete plant.

1 BS EN 197-1: Cement — Part 1: Composition, specifications and conformity criteria for common cements
2 BS EN 197-5: Cement — Part 5: Portland-composite cement CEM II/C-M and composite cement CEM VI — Composition, specifications and conformity criteria
3 BS 8500-2: Concrete. Complementary British Standard to BS EN 206 Specification for constituent materials and concrete
4 EN 15804: Sustainability of construction works- Environmental Product Declarations – Core rules for the product category rules of construction products

## Table 1: $CO_2e$ of UK cements

| Cement[a] | Equivalent combination | Clinker proportion of cement | Main constituent added at cement plant or addition(s) added at concrete plant | $CO_2e$[b] Includes transport of all constituent materials to the cement plant but not transport to concrete plant (see section 3.1) |
|---|---|---|---|---|
| | | Proportions (%) | Low – High Content (%) | Clinker/CEM I content High – Low[c] (kg $CO_2e$/tonne) |
| **CEM I**[5] Portland Cement | NA | 95-100 | NA | 840 |
| **CEM II/A-LL or L** Portland Limestone Cement | CIIA-LL or L | 80-94 | 6–20 Limestone fines | 807 - 674 |
| **CEM II/A-V** Portland fly-ash cement | CIIA-V | 80-94 | 6–20 fly ash | 806 - 670 |
| **CEM II/B-V** Portland fly-ash cement | CIIB-V | 65-79 | 21–35 fly ash | 678 - 542 |
| **CEM II/B-S** Portland slag cement | CIIB-S | 65-79 | 21–35 GGBS | 705 - 586 |
| **CEM II/C-M (S-L)** Portland composite cement- GGBS and limestone fines | CIIC-SL | 50-64 | 30-44 GGBS<br>6-20 Limestone fines | 613 - 474 |
| **CEM II/C-M (V-L)** Portland composite cement- fly ash and limestone fines | CIIC-VL | 50-64 | 18-44 Fly ash<br>6-18 Limestone fines | 580 - 441 |
| **CEM III/A** Blastfurnace cement | CIIIA | 35-64 | 36–65 GGBS | 596 - 369 |
| **CEM III/B** Blastfurnace cement | CIIIB | 20-34 | 66-80 GGBS | 378 - 260 |
| **CEM IV/B-V** Pozzolanic (siliceous fly ash) cement | CIVB-V | 45-64 | 36-55 Fly ash | 550 - 372 |
| **CEM VI (S-L)** Composite cement- GGBS and limestone fines | CVI-SL | 36-49 | 44-55 GGBS<br>6-20 Limestone fines | 498 - 367 |
| a | For CEM I, 4% mac and 5% gypsum is assumed. For other cements at the highest proportion of clinker it is assumed that 2% mac is incorporated and at the lowest proportion of clinker it is assumed that mac is added at 4% with the appropriate proportions of fly ash and GGBS. | | | |
| b | $CO_2e$ figures for CEM II/CII, CEM III/CIII, CEM IV/CIV and CEM VI/CVI are based on the maximum to minimum proportion of clinker/ minimum to maximum proportion of addition. $CO_2e$ can be interpolated for proportions of main constituents/ additions between the minimum and maximum, noting that the minimum $CO_2e$ is associated with the lowest clinker/ highest proportion of addition. | | | |
| | The $CO_2e$ for S-L/ SL and V-L/ VL cements/ combinations incorporating more than one main constituent/ addition is based on the proportion giving the minimum and maximum $CO_2e$. | | | |
| c | Please note that not all the cements/combinations shown in this table are currently available in the UK. | | | |

5 UK Average CEM I Environmental Product Declaration, Published 13th April 2022, https://cement.mineralproducts.org/MPACement/media/Cement/Publications/2017/EPD_UK_Average_CEM_I_04-2022.pdf

## 3. Indicative $CO_2e$ of main UK supplementary cementitious materials

The indicative $CO_2e$ of the main supplementary cementitious materials (or additions for concrete) are shown in Table 2. Data are 'cradle to factory gate', so transport from the place of manufacture of the cementitious material to the concrete plant is not included.

### Table 2: $CO_2e$ of UK additions for concrete

| Addition | $kgCO_2e/t$ | Relevant standards |
|---|---|---|
| Ground granulated blastfurnace slag (GGBS)[6] | 155 | Ground granulated blastfurnace slag to BS EN 15167-1 Ground granulated blastfurnace slag for use in concrete mortar and grout — Part 1 Definition, specifications and conformity criteria |
| Fly Ash (from coal burning power generation)[7] | 22 | Fly ash to BS EN 450-1 Fly ash for concrete — Part 1: *Definition, specifications and conformity criteria* |
| Limestone Fines[8] | 44 | Limestone fines to BS 7979 *Specification for limestone fines for use with Portland cement* |
| Calcined Clay[9] | 48 - 274 | Calcined clay to BS 8615 *Specification for pozzolanic materials for use with Portland cement* |

## 4. Transport

### Equations to Include Transport to the Concrete Plant in $CO_2e$

The data in this fact sheet does not include any transport of materials to the concrete plant and this should be added by the concrete manufacturer in order to determine the $CO_2e$ for material consumed at the concrete plant. UK Government emission factors[10] can be used to do this if the mode of transport/vehicle and distance travelled are known.

6 Includes economic allocation https://www.heidelbergmaterials.co.uk/en/products/regen-ggbs. Other EPD information that excludes economic allocation providing a total GWP of $75kgCO_2e/t$ is available: https://share.mediaflow.com/en/?01HEBAH6ZO

7 Includes economic allocation. The value is sourced from OneClick LCA for fresh fly ash. This value aligns with an EPD for fly ash produced in Turkey (https://api.environdec.com/api/v1/EPDLibrary/Files/e8828916-65d3-4e60-4717-08dc81e1106c/Data). Note that there is no fresh fly ash produced in the UK so transport of imported fly ash would need to be added to this figure. The UK Quality Ash Association also provides information on the embodied carbon of fresh fly ash without economic allocation (1 $kgCO_2e/t$) and Stockpiled fly ash (up to 93.7 $kgCO_2e/t$) (https://www.ukqaa.org.uk/wp-content/uploads/2024/05/CO2-allocation-for-CDFA-Final.pdf).

8 Data provided by Omya for Betocarb limestone fines product.

9 The data in Table 1 does not currently include calcined clay. MPA has investigated the production of calcined clay from reclaimed clay sources and tested cements and concretes produced with it. However, the wide range of clay sources available and the different methods of calcination (rotary or flash) mean that assessing its embodied carbon is challenging. Information available include an Ecoinvent data point of 274 $kgCO_2e/t$ and Novaclay have published an EPD with a GWP of 48 $kgCO_2e/t$ (NEPD-6959-6348_NovaClay-Calcined-Clay-1.pdf).

10 Government emission conversion factors for greenhouse gas company reporting, https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

## 5. Interpolation of $CO_2e$ in Table 1

As stated in the footnote to Table 1, values may be interpolated. For example:

| | |
|---|---|
| **CEM II/A-LL** declared by the manufacturer at 15% limestone is: | 722 kg $CO_2$/tonne |
| NOTE. That is the difference between the high and low $CO_2e$ figures for CEM II/A-LL (807 - 674 = 133) divided by the high and low difference in proportions (20 – 6 = 14) giving 133 ÷ 14 = 9.5 per 1%. 15% limestone is 5% lower than 20% so the $CO_2e$ value is: 674 + (5 x 9.5) = 722 kg $CO_2$/tonne to the nearest tonne. | |

Similarly:

| | |
|---|---|
| **CEM II/B-V** declared by the cement manufacturer at 30% fly ash is: | 591 kg $CO_2$/tonne |
| **CEM III/A** declared by the cement manufacturer at 40% GGBS is: | 564 kg $CO_2$/tonne |
| **CEM III/A** declared by the cement manufacturer at 50% GGBS is: | 486 kg $CO_2$/tonne |
| **CEM III/B** at 70% GGBS is: | 344 kg $CO_2$/tonne |

## 6. Where can I find out more?

For information on the methodology used in this fact sheet please contact Dr D. Casey (Diana.Casey@mineralproducts.org) at MPA.


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|---|---|---|
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