Embodied carbon dioxide (CO_2e) of concretes used in buildings

CONCRETE APPLICATION	Concrete designation	CO_2e ($kgCO_2e/m^3$)[1]			CO_2e ($kgCO_2e$/tonne)[1]		
		CEM I concrete	30% fly ash concrete	50% ggbs concrete	CEM I concrete	30% fly ash concrete	50% ggbs concrete
Blinding, mass fill, strip footings, mass foundations, trench foundations [2]	GEN1	177	128	101	77	55	44
Reinforced Foundations [2]	RC25/30**	316	263	197	133	111	83
Ground floors [2]	RC28/35 *	316	261	186	134	110	79
Structural: in situ floors, superstructure, walls, basements [2]	RC32/40 **	369	313	231	154	131	96
High strength concrete [2]	RC40/50 **	432	351	269	178	146	111
		CO_2e ($kgCO_2e/m^3$)			CO_2e ($kgCO_2e$/tonne)		
Unreinforced Precast flooring[3]		-			165		
Reinforced precast flooring[3]		-			171		
Average Generic Concrete Block[4]		-			84		

* *includes 30kg/m^3 steel reinforcement*

** *includes 100kg/m^3 steel reinforcement*

Notes:

1. Some of the data used to produce these figures were based on CO_2 emissions only. It is calculated that the use of this data will have no significant impact on the actual values provided.
2. The CO_2e figures were derived using average industry data. The figures for cementitious materials are taken from the updated Fact Sheet 18 based on (CO_2e) 2010 data. The figures include production emissions and transport of concrete and blocks to the building site, as determined from average 2011 industry data.
3. Data taken from the British Precast Fact Sheet “Carbon Footprint of Concrete Flooring” (13/04/2012)
4. Data taken from the British Precast Fact sheet “Generic Carbon Footprint of Aggregate Blocks” (11/02/2013)

The table sets out the average CO_2e values for a range of common concretes and concrete blocks used in building. These figures incorporate reductions in specific CO_2e emissions achieved by improving manufacturing efficiency. However, the scope of the data has been extended to be in line with PAS 2050 and BS EN 15804 (Stages A1-A4) and this means the overall reductions observed are fairly modest.

The use of ground granulated blastfurnace slag (ggbs) or fly-ash (also known as pulverized-fuel ash or pfa) may improve longer term strength and durability as well help reduce the embodied CO_2e levels of concrete in which it is used. With increasing proportions of ggbs and fly-ash the early strength can be lower for concretes of similar 28 day strength. This effect is more significant at colder temperatures. Where striking times are critical, the performance of these mixes with respect to early strength may need to be confirmed.

It must be remembered that sustainability is about environmental, social and economic issues, not just the single issue of greenhouse gas emissions. In addition the whole life performance of a building/project must be considered rather than just the embodied impacts. The choice of construction material should depend on all of the benefits it contributes to optimising building performance, and important attributes such as thermal mass should not be overlooked.