RC30 CEM I

Key Information

General Process Description	This dataset represents average end-of-life conditions for RC30 reinforced concrete manufactured with CEM I Portland cement. Reinforcement has been assumed to be 2% by volume, equivalent to 156kg/m^3 of concrete.
Reference Flow	1kg of reinforced concrete (2% reinforcement)
Reference Year	2012

Modelling & Assumptions

Detailed model description

This dataset represents average end-of-life conditions for RC30 reinforced concrete manufactured with CEM I Portland cement and used in a building in the UK. The reference unit is 1kg of reinforced concrete. Users wishing to use this data to make comparisons between different structures and/or different materials should consider the amount of material required for the relevant structural function as comparing on a per kg basis may be misleading.

Reinforcement has been assumed to be 2% by volume, equivalent to 156kg/m^3 of concrete. The concrete is assumed to be made from 100% primary material i.e. with no recycled content in either the cement or aggregates.

Recycling Rates

The recycling, reuse and landfill rates used in modelling the end of life treatment of RC30 (CEM I) are as follows.

Material	*Concrete*	*Rebar*
Recycling Rate	Recycling: 90% Landfill: 10%	Recycling: 98% Reuse: 0% Landfill: 2%
Reference	[BRE 2012]	[Eurofer 2012]

Both of these references were based on research into the end of life treatment of the materials in question in the UK and were therefore deemed fully representative of average treatment in the UK of concrete and rebar.

Module Description

The dataset includes the following waste processing steps (EN 15804 module code shown in brackets):

- **Demolition (C1):** Demolition has been modelled based on information related to the demolition of office building structural systems [Athena 1997]. The cited report listed energy demands from diesel for the demolition of concrete, wood and steel-based structural frames. Energy demand varies depending on the type of building element being demolished, so an average for 1kg of reinforced concrete was made. Overall, the average energy demand for demolition from diesel was calculated to be 0.068 MJ/kg.

- **Transport of Concrete (C2):** Transport distances for concrete are based on average transport distances for waste concrete to waste transfer stations or directly to recycling centres and landfill [BRE 2012]. Using these figures, the distance for concrete sent to recycling was assumed to be 20km. For waste sent to landfill this was 22km. Transport was assumed to be in industrial waste skips (>12m3 up to 20t), with skips unloaded on the outward journey and fully loaded on the return.

- **Transport of Steel (C2):** Transport distances for steel sent to landfill or reuse are based on average travel for construction steel scrap sent to waste transfer stations, an average distance of 21km [BRE 2012]. Steel scrap generated in the UK and sent for recycling was deemed to have three potential destinations: BF steel production in the UK, EAF steel production in the UK or export. An average was made based on the weighted transport distance to BF, EAF and export using information on steel waste arisings and fates [EMR 2006] [EEF 2010]. For BF, transport distance was calculated based on average distance by road from ten UK urban areas to Scunthorpe and Port Talbot (where Tata Steel operate blast furnaces). For EAF, transport was based on distance to South Wales and South Yorkshire where all bar one of the UK's EAF producers are based. For export, transport by road and ship to Luxembourg and Germany was deemed representative. Based on this averaging method, the overall transport distance for 1kg of steel scrap was calculated to be 463km by road and 158km by ship.

- **Concrete crushing (C3):** Concrete crushing is based on a generic crusher used for processing construction rubble. The overall loss rate of the crusher used for modelling this process was 3.1%

- **Landfill of concrete (C4):** The dataset used for modelling the landfill of concrete represents the environmental profile of inert waste in a typical European municipal waste landfill. Recarbonation of concrete in landfill has also been included based on the method outlined in the BRE environmental profiles methodology document [BRE 2007].

- **Landfill of rebar (C4):** The dataset used for modelling the landfill of rebar represents the environmental profile of inert waste in a typical European municipal waste landfill.

- **Benefits/Loads associated with rec. concrete (D):** Crushed concrete generated from the recycling process can be used as aggregates or fill materials for a number of construction applications including road building or as an aggregate for fresh concrete. To reflect the potential benefits associated with using crushed concrete in place of virgin aggregates, an average was made of different rocks used in construction applications (including road building) using information from the Office of National Statistics related to quantities of minerals extracted in Great Britain in 2010 [ONS 2011]. Included in this average were limestone, igneous rock, unspecified mixed crushed rock, sand and gravel. Recarbonation of the recycled aggregate is not included in module D in accordance with the BRE's

	EN15804 Product Category Rules [BRE 2013]. - **Benefits/Loads associated with rebar recycling (D):** The benefit of recycling rebar was calculated based on the "net scrap" generated over the lifetime of the rebar product. This net scrap value was calculated based on the output of steel scrap sent to recycling at end-of-life minus the input of steel scrap into the product system to produce rebar. For rebar, the end of life recycling rate was 98% or 0.98kg of scrap/kg of rebar and the average input of scrap into rebar products according to worldsteel is 0.698 kg of scrap/kg of rebar, resulting in a net scrap of 0.282kg/kg of rebar. The credit applied uses the worldsteel value of scrap, based on the difference between the LCI of EAF steel and a 100% primary BF route [worldsteel 2011].

Representativeness

Time representativeness	Recycling rates and other assumptions are based on the most recent data available, the oldest of which was published ten years ago. Background data is for the year 2013.
Geographical Representativeness	The methods and rates modelled are based on research of reinforced concrete disposal and disposal of the component materials in the UK. Background datasets are UK specific, EU average or Global average (see included datasets list), but are deemed representative for end of life waste treatment in the UK
Technological Representativeness	All technological processes deemed relevant for waste treatment of reinforced concrete in the UK have been modelled.

Included Datasets

Dataset List	GB: Thermal Energy from Light Fuel Oil
	EU-27: Diesel Mix
	Global: Euro 5 Truck, 9.3t payload capacity
	Global: Euro 5 Truck, 22t payload capacity
	Global: Ship - Bulk commodity carrier, 10,000t DWT
	DE: Processing Facility (Construction Rubble)
	EU-27: Lubricants
	EU-27: Wax/Paraffin
	EU-27: Light Fuel Oil
	EU-27: Landfill of inert waste
	EU-27: Landfill of inert matter (steel)
	RER: Gravel 2/32
	RER: Sand 0/2
	DE: Limestone, crushed
	DE: Lava granulate
	DE: Crushed Rock 16-32mm
	Global: Value of scrap - worldsteel
	Global: Steel rebar – worldsteel

Conformity with EN 15804

The models used in this work have been designed to be conformant with the EN 15804 standard. Wherever possible, upstream datasets that are conformant with the EN 15804 standard have been used (see "Included Datasets"). However, not all data providers have been able to update their datasets to comply with the reporting of water and waste indicators according to the standard. The following datasets used in this work are not conformant with EN 15804.

- *Global: Value of scrap – worldsteel*
- *Global: Steel rebar – worldsteel*

These inventories represent 1.42% of the EoL modelling by mass, so are not deemed likely to be significant in terms of the reporting of these waste and water categories.

The models and results have been produced in line with the EN 15804 standard and have undergone quality assurance by experts within PE INTERNATIONAL. However, no formal review process through a third party has been undertaken therefore the results are unverified.

Environmental Parameters Derived from the LCA

Parameters describing environmental impacts		C1	C2	C3	C4	D
Global Warming Potential	kg CO2 eq.	0.0056	0.0042	0.0022	-0.0040	-0.0314
Ozone Depletion Potential	kg CFC11 eq.	3.85E-15	1.99E-14	3.20E-14	1.75E-14	8.47E-10
Acidification Potential	kg SO2 eq.	1.14E-05	1.41E-05	1.70E-05	8.19E-06	-8.20E-05
Eutrophication Potential	kg PO4 eq.	2.23E-06	3.03E-06	3.70E-06	1.12E-06	-5.36E-06
Photochemical Ozone Creation Potential	kg Ethene eq.	1.03E-06	-3.62E-06	2.36E-06	7.69E-07	-1.41E-05
Abiotic Depletion Potential (elements)	kg Sb eq.	6.19E-11	1.57E-10	3.36E-09	4.84E-10	-2.71E-07
Abiotic Depletion Potential (fossil)	MJ	0.077	0.058	0.043	0.017	-0.339

Parameters describing primary energy		C1	C2	C3	C4	D
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	6.54E-05	2.20E-03	1.35E-03	1.46E-03	4.87E-03
Use of renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0	0	0
Total use of renewable primary energy resources	MJ, net calorific value	6.54E-05	2.20E-03	1.35E-03	1.46E-03	4.87E-03
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value	0.077	0.058	0.044	0.018	-0.320
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0	0	0
Total use of non-renewable primary energy resources	MJ, net calorific value	0.077	0.058	0.044	0.018	-0.320
Use of secondary material	kg	0	0	0	0	0.833
Use of renewable secondary fuels	MJ, net calorific value	3.82E-07	3.71E-07	0	3.17E-05	-9.18E-06
Use of non-renewable secondary fuels	MJ, net calorific value	4.00E-06	3.88E-06	0	6.85E-05	-2.80E-05
Net use of fresh water	m^3	3.61E-07	1.57E-06	1.03E-05	-6.75E-05	-2.91E-04

Other environmental information describing waste categories		C1	C2	C3	C4	D
Hazardous waste disposed	kg	7.55E-08	1.30E-07	5.80E-07	7.94E-07	-1.09E-05
Non-hazardous waste disposed	kg	9.44E-06	7.06E-06	1.89E-05	9.52E-02	-2.46E-02
Radioactive waste disposed	kg	7.16E-08	7.56E-08	4.65E-07	3.09E-07	4.46E-06

Other environmental information describing output flows		C1	C2	C3	C4	D
Components for re-use	kg	0	0	0	0	0
Materials for recycling	kg	0.0610	0	0.819	0	0
Materials for energy recovery	kg	0	0	0	0	0
Exported energy	MJ per energy carrier	0	0	0	0	0

References

Athena 1997	Athena Sustainable Materials Institute, 1997. *Demolition Energy Analysis of Office Building Structural Systems.*
BRE 2007	BRE, 2007. *Methodology for Environmental Profiles of Construction Products*, Appendix 5, p. 68. BRE: Watford.
BRE 2012	Anderson, J., Adams, K. and Shiers, D., 2012. *Minimising the Environmental Impact of Construction Waste*. In press. BRE: Watford
BRE 2013	BRE, 2013. *Product Category Rules for Type III environmental declaration of construction products to EN 15804:2012.* BRE: Watford
BS EN 15804:2012	British Standards Institution, 2012. *BS EN 15804:2012 Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products. London: BSI*
EEF 2010	EEF, 2010. *UK Steel Key Statistics 2010.* EEF: London.
EMR 2006	European Metal Recycling, 2006. *Metals Recycling - UK ferrous scrap market.*
Eurofer 2012	*Eurofer survey of National Federation of Demolition Contractors (NFDC),* 2012. Survey data compiled by Tata Steel Europe RD&T. Rotherham, UK. http://www.steelconstruction.info/The_recycling_and_reuse_survey
ONS 2011	Office for National Statistics, 2011. *Mineral Extraction in Great Britain - 2010.* Newport: ONS
worldsteel 2011	World Steel Association, 2011. *Life Cycle Inventory Study for Steel Products - Methodology Report.* Brussels: World Steel Association