Brickwork

Key Information

General Process Description	This dataset represents average end-of-life conditions for brickwork in the UK. The modelled product includes mortar.
Reference Flow	1kg of brickwork (inc. mortar)
Reference Year	2012

Modelling & Assumptions

Detailed model description

This dataset represents average end-of-life conditions for brickwork used in a building in the UK. The reference unit is 1kg of brickwork. 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.

The modelled bricks are assumed to have a density of 1922kg/m^3. A standard house brick size of 102.5x215x65mm has been assumed with 10mm mortar joints. This gives a brickwork system that is 82.8% concrete block by volume with 17.2% mortar. Buildings constructed today will generally use cement mortar with brickwork. However, some building projects still use traditional lime or lime/cement mortar. In this study, it is assumed that the proportion of lime or lime/cement mortar brickwork is less than 10%. The bricks are assumed to be made from 100% primary material i.e. contain no recycled content.

Recycling Rates

The recycling and landfill rates used in modelling the end of life treatment of brickwork are as follows.

Material	*Brickwork*	*Mortar*
Recycling Rate	Recycling: 80%	Recycling: 80%
	Reuse: 10%	Landfill: 20%
	Landfill: 10%	
Reference	Adapted from [BRE 2012]	Adapted from [BRE 2012]

The BRE reference lists a 40% reuse rate for bricks. However, this is based on a survey of current demolition practice at a sample of sites in the UK. At present, many sites that are demolished include old brickwork constructed with lime cement, which allows for reuse of the bricks (but is less durable and more expensive…). Brickwork constructed with cement mortar is seldom, if ever reused as the bricks and mortar cannot be separated. Therefore, to be representative for the predominantly cement mortar system modelled here, the reuse figure has been revised down to 10%, with the recycling rate increased from 50% to 80%. It has been assumed that mortar cannot be reused and that mortar removed from bricks prior to reuse is sent to landfill.

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, but not for brickwork. In the absence of specific information regarding brickwork, the energy required for demolition was based on the energy requirements for the demolition of concrete walls (both internal and external), as this is likely to be similar to the energy required for the demolition of brick walls in the building industry. Based on this assumption, the average energy demand for demolition from diesel was calculated to be 0.058 MJ/kg.

- **Transport of Brickwork (C2):** Transport distances for concrete blocks are based on average transport distances for bricks to waste transfer stations or directly to recycling centres and landfill [BRE 2012]. Using these figures, the distance for bricks sent to reuse and recycling was assumed to be 19km. For waste sent to landfill this was 14km. 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.

- **Brick crushing (C3):** Brick 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 bricks/mortar (C4):** The dataset used for modelling the landfill of bricks represents the environmental profile of inert waste in a typical European municipal waste landfill.

- **Benefits/Loads associated with rec. bricks/mortar (D):** Crushed brick generated from the recycling process can be used as aggregate or fill materials for a number of construction applications including road building. To reflect the potential benefits associated with using crushed brick 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.

- **Benefits/Loads associated with reuse of bricks (D):** Where lime or lime/cement mortar is used, bricks can be reused by separating the mortar from the brick. As explained above, brickwork constructed with cement mortar cannot generally be reused. It is assumed that the bricks are in a state ready for reuse upon leaving the demolition site. Therefore, no off-site reuse processes are assumed. The reused bricks are assumed to directly displace the need for new bricks on a 1:1 basis and this benefit is recorded in module D.

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 construction projects in the UK. Background datasets are UK specific, EU average or Global average (see included datasets list) where possible. Some German background datasets are used, but are deemed representative for the processes or materials they represent in the UK
Technological Representativeness	All technological processes deemed relevant for waste treatment of concrete blockwork 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
	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
	DE: Facing Brick
	DE: Processing Facility (Construction Rubble)

Conformity with EN 15804

	The models used in this work have been designed to be conformant with the EN 15804 standard and all upstream datasets used are also conformant with the standard. Both the model 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.	0.0048	0.0015	0.0021	0.0016	-0.0207
Ozone Depletion Potential	kg CFC11 eq.	3.28E-15	7.31E-15	3.03E-14	2.17E-14	-4.96E-13
Acidification Potential	kg SO2 eq.	9.70E-06	4.83E-06	1.61E-05	1.01E-05	-5.61E-05
Eutrophication Potential	kg PO4 eq.	1.90E-06	1.03E-06	3.51E-06	1.39E-06	-7.93E-06
Photochemical Ozone Creation Potential	kg Ethene eq.	8.80E-07	-1.41E-06	2.24E-06	9.52E-07	-5.93E-06
Abiotic Depletion Potential (elements)	kg Sb eq.	5.28E-11	5.76E-11	3.19E-09	6.00E-10	-1.71E-09
Abiotic Depletion Potential (fossil)	MJ	0.066	0.021	0.041	0.021	-0.306

Parameters describing resources use		C1	C2	C3	C4	D
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	5.58E-05	8.30E-04	1.28E-03	1.81E-03	-1.68E-02
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	5.58E-05	8.30E-04	1.28E-03	1.81E-03	-1.68E-02
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value	0.066	0.021	0.042	0.022	-0.326
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	0.066	0.021	0.042	0.022	-0.326
Use of secondary material	kg	0	0	0	0	0.858
Use of renewable secondary fuels	MJ, net calorific value	3.26E-07	1.36E-07	0	3.93E-05	-1.10E-05
Use of non-renewable secondary fuels	MJ, net calorific value	3.41E-06	1.42E-06	0	8.48E-05	-5.07E-05
Net use of fresh water	m^3	3.08E-07	5.86E-07	9.79E-06	-8.37E-05	-1.66E-04

Other environmental information describing waste categories		C1	C2	C3	C4	D
Hazardous waste disposed	kg	6.44E-08	4.82E-08	5.50E-07	9.84E-07	-2.03E-05
Non-hazardous waste disposed	kg	8.05E-06	2.66E-06	1.79E-05	1.18E-01	-2.34E-02
Radioactive waste disposed	kg	-6.11E-08	-2.77E-08	-4.40E-07	-3.83E-07	8.10E-06

Other environmental information describing output flows		C1	C2	C3	C4	D
Components for re-use	kg	0	0	0.0822	0	0
Materials for recycling	kg	0	0	0.776	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
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.*
Ley et al. 2002	Ley et al, 2002. *An environmental and material flow analysis of the UK steel construction sector*, p. 73.
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