Statement of Verification

BREG EN EPD No.: 000370 Issue 01

This is to verify that the

Environmental Product Declaration

provided by:

Durisol UK

BRE Global Verified EPD

is in accordance with the requirements of:

EN 15804:2012+A1:2013

and

BRE Global Scheme Document SD207

This declaration is for:

Durisol D365 Standard Block

Company Address

Parkway
Pen-Y-Fan Industrial Estate
Crumlin
NP11 3EF

Signed for BRE Global Ltd	Emma Baker Operator	15 October 2021 Date of this Issue
15 October 2021 Date of First Issue		14 October 2026 Expiry Date

BRE Global Verified EPD

BRE Global Ltd., Garston, Watford WD25 9XX.
T: +44 (0)333 321 8811 F: +44 (0)1923 664603 E: Enquiries@breglobal.com

ECO PLATFORM EPD EN 15804 VERIFIED

Environmental Product Declaration

EPD Number: 000370

General Information

EPD Programme Operator	Applicable Product Category Rules
BRE Global Watford, Herts WD25 9XX United Kingdom	BRE Environmental Profiles 2013 Product Category Rules for Type III environmental product declaration of construction products to EN 15804:2012+A1:2013
Commissioner of LCA study	**LCA consultant/Tool**
Durisol UK Parkway Pen-Y-Fan Industrial Estate Crumlin NP11 3EF	Andrew Dutfield/ BRE LINA 2.0
Functional Unit	**Applicability/Coverage**
1 Durisol D365 Standard Block weighing 13.5 kg, dimensions 250 mm x 500 mm x 365 mm, as installed over a 60 year period.	Manufacturer Specific Product.
EPD Type	**Background database**
Cradle to Grave	ecoinvent v3.2

Demonstration of Verification
CEN standard EN 15804 serves as the core PCR [a]
Independent verification of the declaration and data according to EN ISO 14025:2010 ☐Internal ☒ External
(Where appropriate [b])Third party verifier: Pat Hermon
a: Product category rules b: Optional for business-to-business communication; mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4)

Comparability
Environmental product declarations from different programmes may not be comparable if not compliant with EN 15804:2012+A1:2013. Comparability is further dependent on the specific product category rules, system boundaries and allocations, and background data sources. See Clause 5.3 of EN 15804:2012+A1:2013 for further guidance

Information modules covered

Product			Construction		Use stage							End-of-life					Benefits and loads beyond the system boundary
					Related to the building fabric					Related to the building							
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
Raw materials supply	Transport	Manufacturing	Transport to site	Construction – Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal		Reuse, Recovery and/or Recycling potential
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑		☐

Note: Ticks indicate the Information Modules declared.

Manufacturing site(s)

Durisol UK
Parkway
Pen-Y-Fan Industrial Estate
Crumlin
NP11 3EF

Construction Product:

Product Description

The Durisol Permanent Formwork System is manufactured from primarily recycled woodchip, cement and recycled production waste. It is used in loadbearing and non-loadbearing internal, external and separating walls in domestic or commercial buildings. The product is used a static permanent formwork for in-situ dense-aggregate concrete walls and contributes to the thermal insulation and acoustic performance of the finished construction. It is concealed beneath coverings (plaster, render etc) where it will sit passively for the life of the structure.

Technical Information

Property	Value, Unit
Block dimensions	Height 250 mm x Length 500 mm x Width 365 mm
Thermal conductivity lambda value (based upon a product density of 610 kg·m^{-3})	0.12 W·m^{-1}·K^{-1}
Fire Classification: BS EN 13501-1 : 2018	Not classified

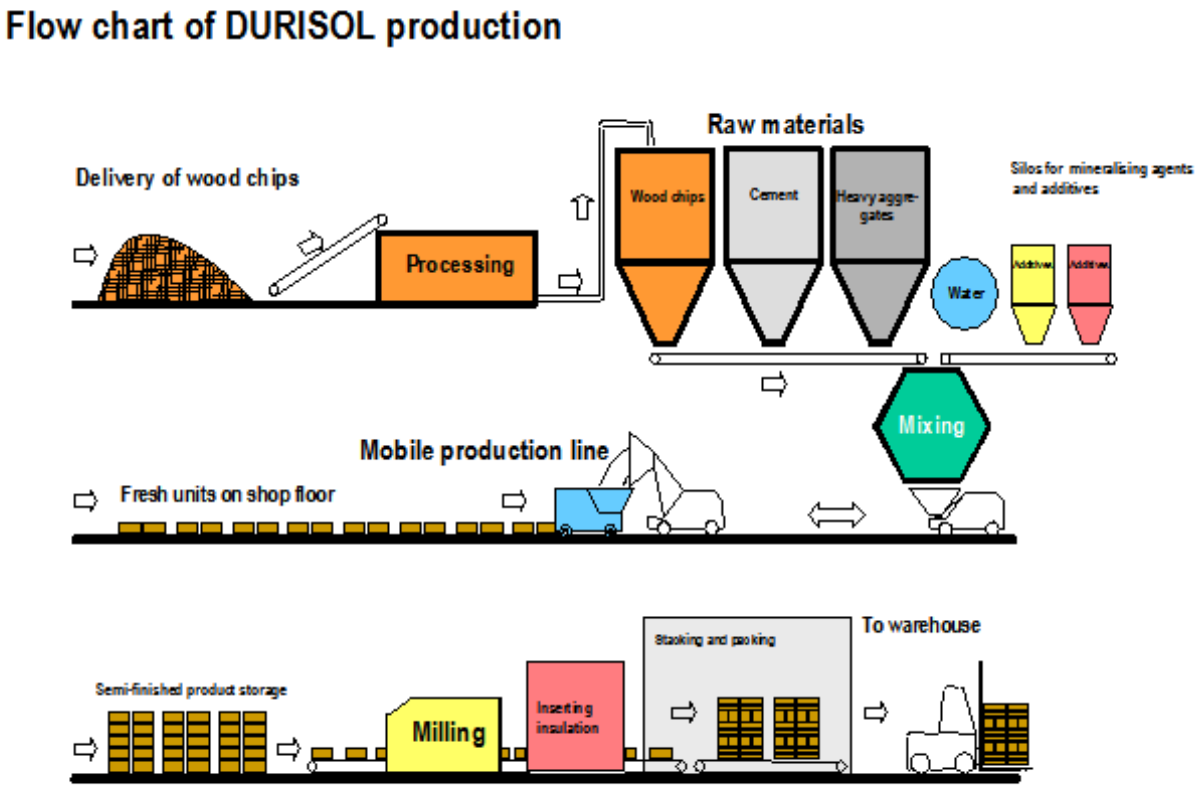
Main Product Contents

Material/Chemical Input	%
Woodchip	43.8
Cement	48.2
Blockmeal	7.7
Aluminium Sulphate	0.2
Lime	0.1

Manufacturing Process

Recycled woodchip is mineralised through a chemical treatment process and then mixed with Cem1 type cement before being dosed into a mobile block laying machine that presses blocks out onto the factory floor. Once sufficiently cured, the blocks are trimmed, packed and stored.

Process flow diagram



Construction Installation

Durisol is an ICF system so the units act as permanent formwork and are filled with wet concrete on site. The units are dry stacked with no mortars or resins as they simply mechanically interlock with the tongue and groove block shape. The units are then braced on the corners and anywhere a cut unit is being used with a piece of ply screwed to the block to stabilise it against the adjoining units. Both the ply and screws can be removed and reused once the concrete has been poured into the units and has cured. The process is simple and does not involve any accompanying materials.

Use Information

The product is static permanent formwork concealed beneath coverings (plaster, render etc) where it will sit passively for the life of the structure. Therefore no impacts are associated with the use stage of the Durisol D365 Standard Block over the lifetime of its installation.

End of Life

Durisol D365 Standard Block is inert and can be crushed down and used as general fill material in the same way the concrete infill can be crushed and repurposed.

Life Cycle Assessment Calculation Rules

Functional unit description

1 Durisol D365 Standard Block weighing 13.5 kg, dimensions 250 mm x 500 mm x 365 mm, as installed over a 60 year period.

System boundary

This is a cradle to grave EPD referring specifically to the D365 Standard Block product, reporting all production life cycle stages of modules from A1 to C4 inclusive in accordance with EN 15804:2012+A1:2013 but excluding module D.

Data sources, quality and allocation

Manufacturer-specific data from Durisol for the production of the D365 Standard block product at the Crumlin site for the period 1st January 2020 to 31st December 2020 has been used for this EPD. As there were more input materials than output materials (including waste), this resulted in a mass balance of 103% which is due to evaporation of the finished product as it dries out.

Durisol manufacture other products at the Crumlin site. Site wide values for energy, water, waste and wastewater have been allocated by mass of production. D365 Standard block product forms 42.5% of total production. Fine woodcrete trimming waste does not need any further processing before being recycled for agricultural uses.

As the manufacturing process for recycling woodchip is uncertain, the dataset for virgin woodchip has been used.

Data for distance to installation and water usage for installation were supplied by Durisol. Other items used in the construction of a wall such as concrete infill, insulation and reinforcing have not been included. The waste created at installation is assumed to go to landfill. Plywood sheeting held together with screws is used to brace the formwork during the pouring of concrete infill. The weight of screws is assumed to be negligible and has not been included. Both the plywood and screws can be re-used.

The product is static permanent formwork concealed beneath coverings (plaster, render etc) where it will sit passively for the life of the structure. Therefore no impacts are associated with the use stage of the Durisol D365 Standard Block over the lifetime of its installation. Therefore, the impact of these modules is assumed to be zero.

It is assumed that when the Durisol D365 Standard Block is removed from its structure, this is part of demolition of the whole structure. Therefore, impacts must be allocated to the whole structure and it is assumed that those allocated to the block alone are negligible, and can be assumed to be zero.

10% of the functional unit is assumed to go to landfill whilst the remaining 90% exits the system boundary to be reused on site. It is assumed that the landfill site is local and 20 km away from the construction site. Data for the energy used in deconstruction, transport to the crushing plant and energy of crushing at end of life have been derived from an academic source for the crushing of limestone.

Figures for the raw materials, ancillary materials and packaging were from actual usages. Allocation of energy, water, and waste has been done according to the provisions of the BRE PCR PN514 and EN 15804. Secondary data have been drawn from the BRE LINA database v2.0.82 and the background LCI datasets are based on ecoinvent v3.2 (2015).

Quality Level	Geographical representativeness	Technical representativeness	Time representativeness
Very Good	Data from area under study	Data from processes and products under study. Same state of technology applied as defined in goal and scope (i.e. identical technology)	n/a
Fair	n/a	n/a	Less than 10 years of difference between the reference year according to the documentation, and the time period for which data are representative

The quality level of geographical and technical representativeness is Very Good. The quality level of time representativeness is Fair as the background LCI datasets are based on ecoinvent v3.2 which was compiled in 2015 and so there is less than 10 years between the reference year according to the documentation, and the time period for which data are representative.

Cut-off criteria

No inputs or outputs have been excluded and all raw materials, packaging and transport, energy, water use and wastes, are included, except for direct emissions to air, water and soil, which are not measured. Upstream extraction and/or processing of inputs are included within the use of the background datasets within LINA.

LCA Results

(MND = module not declared; MNR = module not relevant; INA = indicator not assessed; AGG = aggregated)

Parameters describing environmental impacts									
			GWP	ODP	AP	EP	POCP	ADPE	ADPF
			kg CO_2 equiv.	kg CFC 11 equiv.	kg SO_2 equiv.	kg $(PO_4)^{3-}$ equiv.	kg C_2H_4 equiv.	kg Sb equiv.	MJ, net calorific value.
Product stage	Raw material supply	A1	AGG	AGG	AGG	AGG	AGG	AGG	AGG
	Transport	A2	AGG	AGG	AGG	AGG	AGG	AGG	AGG
	Manufacturing	A3	AGG	AGG	AGG	AGG	AGG	AGG	AGG
	Total (of product stage)	A1-3	4.05E+00	3.65E-07	1.84E-02	5.38E-03	2.67E-03	4.80E-06	4.95E+01
Construction process stage	Transport	A4	2.26E-01	4.15E-08	7.55E-04	1.99E-04	1.32E-04	5.94E-07	3.41E+00
	Construction	A5	-6.81E-02	2.53E-08	1.18E-03	2.56E-03	2.22E-04	4.91E-07	3.09E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	C2	4.51E-02	8.31E-09	1.51E-04	3.98E-05	2.63E-05	1.19E-07	6.82E-01
	Waste processing	C3	2.04E-02	1.32E-09	1.10E-04	2.53E-05	6.28E-06	2.46E-08	3.14E-01
	Disposal	C4	1.40E-02	3.68E-09	9.77E-05	3.21E-05	1.63E-05	1.98E-08	3.43E-01
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	MND	MND	MND	MND	MND	MND	MND

GWP = Global Warming Potential;
ODP = Ozone Depletion Potential;
AP = Acidification Potential for Soil and Water;
EP = Eutrophication Potential;
POCP = Formation potential of tropospheric Ozone;
ADPE = Abiotic Depletion Potential – Elements;
ADPF = Abiotic Depletion Potential – Fossil Fuels;

LCA Results (continued)

Parameters describing resource use, primary energy								
			PERE	PERM	PERT	PENRE	PENRM	PENRT
			MJ	MJ	MJ	MJ	MJ	MJ
Product stage	Raw material supply	A1	AGG	AGG	AGG	AGG	AGG	AGG
	Transport	A2	AGG	AGG	AGG	AGG	AGG	AGG
	Manufacturing	A3	AGG	AGG	AGG	AGG	AGG	AGG
	Total (of product stage)	A1-3	4.98E+01	6.65E-06	4.98E+01	5.61E+01	0.00E+00	5.61E+01
Construction process stage	Transport	A4	4.53E-02	1.69E-07	4.53E-02	3.39E+00	0.00E+00	3.39E+00
	Construction	A5	6.38E+00	4.22E-07	6.38E+00	3.42E+00	0.00E+00	3.42E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	C2	9.05E-03	3.37E-08	9.05E-03	6.77E-01	0.00E+00	6.77E-01
	Waste processing	C3	2.71E-02	4.89E-08	2.71E-02	4.18E-01	0.00E+00	4.18E-01
	Disposal	C4	1.05E-02	2.87E-08	1.05E-02	3.45E-01	0.00E+00	3.45E-01
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	MND	MND	MND	MND	MND	MND

PERE = Use of renewable primary energy excluding renewable primary energy used as raw materials;
PERM = Use of renewable primary energy resources used as raw materials;
PERT = Total use of renewable primary energy resources;
PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials;
PENRM = Use of non-renewable primary energy resources used as raw materials;
PENRT = Total use of non-renewable primary energy resource

LCA Results (continued)

Parameters describing resource use, secondary materials and fuels, use of water						
			SM	RSF	NRSF	FW
			kg	MJ net calorific value	MJ net calorific value	m^3
Product stage	Raw material supply	A1	AGG	AGG	AGG	AGG
	Transport	A2	AGG	AGG	AGG	AGG
	Manufacturing	A3	AGG	AGG	AGG	AGG
	Total (of product stage)	A1-3	1.23E+00	0.00E+00	0.00E+00	2.78E-02
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	7.39E-04
	Construction	A5	3.70E-02	0.00E+00	0.00E+00	3.63E-03
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	C2	0.00E+00	0.00E+00	0.00E+00	1.48E-04
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	8.35E-05
	Disposal	C4	0.00E+00	0.00E+00	0.00E+00	3.86E-04
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	MND	MND	MND	MND

SM = Use of secondary material;
RSF = Use of renewable secondary fuels;
NRSF = Use of non-renewable secondary fuels;
FW = Net use of fresh water

LCA Results (continued)

Other environmental information describing waste categories					
			HWD	NHWD	RWD
			kg	kg	kg
Product stage	Raw material supply	A1	AGG	AGG	AGG
	Transport	A2	AGG	AGG	AGG
	Manufacturing	A3	AGG	AGG	AGG
	Total (of product stage)	A1-3	2.60E-02	4.57E-01	2.75E-04
Construction process stage	Transport	A4	1.43E-03	1.59E-01	2.35E-05
	Construction	A5	2.04E-03	1.06E+00	1.70E-05
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	0.00E+00	0.00E+00	0.00E+00
	Transport	C2	2.86E-04	3.18E-02	4.70E-06
	Waste processing	C3	4.77E-05	5.08E-04	2.30E-06
	Disposal	C4	2.58E-04	1.35E+00	2.12E-06
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	MND	MND	MND

HWD = Hazardous waste disposed;
NHWD = Non-hazardous waste disposed;
RWD = Radioactive waste disposed

LCA Results (continued)

Other environmental information describing output flows – at end of life						
			CRU	MFR	MER	EE
			kg	kg	kg	MJ per energy carrier
Product stage	Raw material supply	A1	AGG	AGG	AGG	AGG
	Transport	A2	AGG	AGG	AGG	AGG
	Manufacturing	A3	AGG	AGG	AGG	AGG
	Total (of product stage)	A1-3	0.00E+00	2.14E+00	0.00E+00	0.00E+00
Construction process stage	Transport	A4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Construction	A5	0.00E+00	6.43E-02	0.00E+00	0.00E+00
Use stage	Use	B1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Maintenance	B2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Repair	B3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Replacement	B4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Refurbishment	B5	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational energy use	B6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Operational water use	B7	0.00E+00	0.00E+00	0.00E+00	0.00E+00
End of life	Deconstruction, demolition	C1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Transport	C2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Waste processing	C3	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Disposal	C4	1.22E+01	0.00E+00	0.00E+00	0.00E+00
Potential benefits and loads beyond the system boundaries	Reuse, recovery, recycling potential	D	MND	MND	MND	MND

CRU = Components for reuse;
MFR = Materials for recycling

MER = Materials for energy recovery;
EE = Exported Energy

Scenarios and additional technical information

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
A4 – Transport to the building site	Durisol supply across the UK but predominantly in Wales, the Midlands and the West Country. This has formed the basis for the 100km assumption on the average site delivery.		
	Diesel/ 16-32 t lorry	kg/vkm	0.3
	Distance:	km	100
	Capacity utilisation (incl. empty returns)	%	26
	Weight of transported products	kg/unit	13.5
A5 – Installation in the building	Durisol is an ICF system so the units act as permanent formwork and are filled with wet concrete on site. The units are dry stacked with no mortars or resins as they simply mechanically interlock with the tongue and groove block shape. The units are then braced on the corners and anywhere a cut unit is being used with a piece of plywood screwed to the block to stabilise it against the adjoining units. Both the plywood and screws can be removed and reused once the concrete has been poured into the units and has cured. The process is simple and does not involve accompanying materials.		
	Plywood sheeting	kg	0.09
	Transport of plywood and screws to installation	km	10
	Transport to installation: Diesel/ 16-32 t lorry	kg/vkm	0.3
	Durisol D365 Standard Block waste at installation (3%)	kg	0.405
	Capacity utilisation (incl. empty returns)	%	26
	Transport of waste to landfill: Diesel/ 16-32 t lorry	kg/vkm	0.3
	Distance	km	20
B1 - Use B2 – Maintenance B3 – Repair B4 – Replacement B5 – Refurbishment	The product is static permanent formwork concealed beneath coverings (plaster, render etc) where it will sit passively for the life of the structure. Therefore no impacts are associated with the use stage of the Durisol D365 Standard Block over the lifetime of its installation. Therefore, the impact of these modules is assumed to be zero.		
Reference service life	Durisol have supplied the following evidence for at least a 60 year service life for the D365 Standard block product. • Paper presenting a study for the renovation of a 50 year old, 8 floors high apartment building, in Graz, Austria (see references). • BBA Agrément Certificate 10/4784, dated 20/01/2012 • Photographic evidence of buildings constructed with the Durisol D365 Standard Block in Canada.		
C1 – End-of-life deconstruction	It is assumed that as when the Durisol D365 Standard Block is removed from its structure, this is part of demolition of the whole structure. Therefore, impacts must be allocated to the whole structure and it is assumed that those allocated to the block alone are negligible, and can be assumed to be zero.		

Scenarios and additional technical information			
Scenario	Parameter	Units	Results
C2 – End-of-life transport	This scenario is based on a 90% reuse / 10% landfill split of construction waste, as evidenced in the UK Government statistics on waste (see references). The scenario assumes that once the wall containing the brick has been knocked down, 100% of it is crushed onsite. Only 90% of the resulting crushed Durisol D365 Standard Block is then usable to go on and leave the system boundary as recycled aggregate onsite, and the remaining 10% is not suitable for reuse, meaning that it goes to landfill. It is assumed that the landfill site is local and 20 km away from the construction site.		
	Diesel/ 16-32 t lorry	kg/vkm	0.3
	Distance	km	20
	Capacity utilisation (incl. empty returns)	%	26
	Weight of transported products	kg/unit	1.35
C3 End-of-life pre-processing	It is assumed that 100% of the Durisol D365 Standard Block rubble is crushed. The energy consumption value was derived from an academic source for the crushing of limestone.		
	Energy consumption for crushing	MJ	0.122
	Crushed block leaving system as recycled aggregate:	kg	12.15
C4 End-of-life disposal	This scenario is based on a 90% reuse / 10% landfill split of construction waste, as evidenced in the UK Government statistics on waste (see references). The scenario assumes that once the wall containing the brick has been knocked down, 100% of it is crushed onsite. Only 90% of the resulting crushed Durisol D365 Standard Block is then usable to go on and leave the system boundary as recycled aggregate onsite, and the remaining 10% is not suitable for reuse, meaning that it goes to landfill.		
	Crushed block going to landfill:	kg	1.35
Module D	Module not declared		

References

BSI. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. BS EN 15804:2012+A1:2013. London, BSI, 2013.

BSI. Environmental labels and declarations – Type III Environmental declarations – Principles and procedures. BS EN ISO 14025:2010 (exactly identical to ISO 14025:2006). London, BSI, 2010.

BSI. Environmental management – Life cycle assessment – Principles and framework. BS EN ISO 14040:2006. London, BSI, 2006.

BSI. Environmental management – Life cycle assessment – requirements and guidelines. BS EN ISO 14044:2006. London, BSI, 2006.

Department for Environment Food & Rural Affairs. Government Statistical Service, UK Statistics on Waste, 2021:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683051/UK_Statisticson_Waste_statistical_notice_Feb_2018_FINAL.pdf

Ciężkowski, Paweł & Maciejewski, Jan & Bąk, Sebastian. (2017). Analysis of Energy Consumption of Crushing Processes – Comparison of One-Stage and Two-Stage Processes. Studia Geotechnica et Mechanica. 39. 10.1515/sgem-2017-0012.

Kubin, Michael & Ham, Michiel. Upgrading of a block of flats (b.1956) through energy efficient renovation, PLEA2006 - The 23rd Conference on Passive and Low Energy Architecture. Geneva, Switzerland, 6-8 September 2006.