The social materials balance of the School Berlaar

Digital Deconstruction: DLT4.2 . Environmental impact of reuse of the inventoried materials

Version May 2023

1. Introduction

By means of an inventory of a building, an overview is made of all materials in a building. This has been done within Digital Deconstruction for all pilots, including the School in Berlaar. This provides insight into the materials that are part of the building, whereby the data of the inventory party is followed. Within Digital Deconstruction, these materials are registered in the Digital Materials Database Cirdax.

With the Co2 module in Cirdax, the Business Economic Value and Co2 Value and the sum of both values can be summarized in a Social Materials Balance Sheet of a Building. This is shown below in a table originating from the Berlaar project within Cirdax.

Materials that are ready for reuse do not have to be produced again. Co2 is released during the production of a large number of materials for the construction of buildings. Reuse saves the CO2 emissions associated with the production processes of building materials. In accordance with the ICE database, we calculate here with the “embodied” Co2 of the materials.

The ICE database describes embodied Co2 as follows: “Embodied carbon comes from the consumption embodied energy consumed to extract, refine, process, transport and fabricate a material or product (including buildings). It is often measured from cradle to (factory) gate, cradle to site (of use), or cradle to grave (end of life). The embodied carbon footprint is therefore the amount of carbon (CO2 or CO2e emission) to produce a material”. Source: https://circularecology.com/embodied-carbon-footprint-database.html

This saving can be given a financial value by multiplying the sum of all Co2 savings of a building by the price for tradable emission allowances, as published daily, for example on www.eex.com . In the spring of 2023, this right will be worth approximately 84 euros per ton/Co2.

In this way we obtain the CO2 balance of a building. The sum of the value and Co2 balance results in the Social Materials Balance, whereby the value balance actually means the financial values of all secondary materials. This will be further explained in the remainder of this document.

In table 1, the 6 leftmost columns contain the data from the digital materials database Cirdax following the inventory that was carried out for the School Berlaar. Table 1 then assumes that all materials from the inventory can actually be reused. This basic assumption is made in view of the value of the materials and the environmental impact, and to show what this value can be. You will also see that in column 7 we have left the size of the reuse equal to the size of the registered materials in the 4th column.

We have adjusted this assumption in table 2 because in reality not every material is actually detachable, as well as the fact that materials can also be lost during the processing of the materials. We have calculated with a loss of material and value of 25%. Because the comparison of Tables 1 and

2 makes it clear what loss of value this may involve, there is also an incentive for every stakeholder to retain this value. Incidentally, we made the adjustment in the columns of the values and not directly in the column of amount of reuse. This is due to the current possibilities to make certain calculations with Cirdax. These possibilities will be extended at a later stage by the integration of removability indices.

Table 1: Social Materials Balance Berlaar with 100% reuse of the materials

School Berlaar										
Social Materials Balance @ 100% reuse of materials							100%	100%	100%	100%
Code	Type	Material (type)	Amount	Volume (m	Weight (kg)	Reuse amo	Co2 (ton)	Co2 (€)	Materials balanc	Social materials
00000001	Outer wall, constructive	Brick	22	712,8	1.069.200,00	22	227,74	19152,9	22.000,00	41.152,90
00000002	Outer wall, constructive	Sand-lime brick	265	0	0	265	0	0	26.500,00	26.500,00
00000003	Outer wall, constructive	Natural stone	2	6,5	13000	2	1,391	116,98	2.000,00	2.116,98
00000004	Floor tile	Ceramics	14000	7,623	18295,2	14000	27,626	2323,33	5.740,00	8.063,33
00000005	Floor tile	Concrete	18500	0,0148	35,52	18500	0,002	0,19	3.749,95	3.750,14
00000006	Outer wall, constructive	Sand-lime brick	4	0	0	4	0	0	1.200,00	1.200,00
00000007	Outer wall, constructive	Natural stone	30	1,8	3600	30	0,385	32,4	3.000,00	3.032,40
00000048	Windowsill	Natural stone	8	5,472	10944	8	1,171	98,48	800,00	898,48
00000049	Windowsill	Natural stone	50	0,3063	612,5	50	0,066	5,51	5.000,00	5.005,51
00000050	Single glass	Glass	3	0	0	3	0	0	75,00	75,00
00000051	Windowsill	Natural stone	11	0,22	440	11	0,047	3,96	1.100,00	1.103,96
00000052	Roof tiles (type unknown)	Ceramic material	5700	0	0	5700	0	0	23.997,00	23.997,00
00000053	Windowsill	Natural stone	3	0,9016	1803,276	3	0,193	16,23	300,00	316,23
00000054	Windowsill	Natural stone	8	0,4992	998,4	8	0,107	8,98	800,00	808,98
00000055	Column (round) general	Cast Iron	6	0,0261	188,103	6	0,19	15,98	6.000,00	6.015,98
00000056	Column (round) general	Cast Iron	2	0,0126	91,066	2	0,092	7,74	2.000,00	2.007,74
00000057	Beam	Wood	8	0	0	8	0	0	200,00	200,00
00000058	Beam	Wood	3	0	0	3	0	0	75,00	75,00
00000059	Beam	Wood	6	0	0	6	0	0	150,00	150,00
00000060	Balustrade	Staal	1	0	0	1	0	0	20,00	20,00
				736,18	**1.119.208,07**		**259,01**	**21.782,68**	**104.706,95**	**126.489,63**

Table 2: Social Materials Balance Berlaar with 75% reuse of the materials

Social Materials Balance @ 75% reuse of materials							75%	75%	75%	75%
Code	Type	Material (type)	Amount	Volume (m	Weight (kg)	Reuse amo	Co2 (ton	C02(€)	Material	SoMaBa
00000001	Outer wall, constructive	Brick	22	712,8	1.069.200,00	22	170,805	14364,675	16.500,00	30.864,68
00000002	Outer wall, constructive	Sand-lime brick	265	0	0	265	0	0	19.875,00	19.875,00
00000003	Outer wall, constructive	Natural stone	2	6,5	13000	2	1,04325	87,735	1.500,00	1.587,74
00000004	Floor tile	Ceramics	14000	7,623	18295,2	14000	20,7195	1742,4975	4.305,00	6.047,50
00000005	Floor tile	Concrete	18500	0,0148	35,52	18500	0,0015	0,1425	2.812,46	2.812,61
00000006	Outer wall, constructive	Sand-lime brick	4	0	0	4	0	0	900,00	900,00
00000007	Outer wall, constructive	Natural stone	30	1,8	3600	30	0,28875	24,3	2.250,00	2.274,30
00000048	Windowsill	Natural stone	8	5,472	10944	8	0,87825	73,86	600,00	673,86
00000049	Windowsill	Natural stone	50	0,3063	612,5	50	0,0495	4,1325	3.750,00	3.754,13
00000050	Single glass	Glass	3	0	0	3	0	0	56,25	56,25
00000051	Windowsill	Natural stone	11	0,22	440	11	0,03525	2,97	825,00	827,97
00000052	Roof tiles (type unknown)	Ceramic material	5700	0	0	5700	0	0	17.997,75	17.997,75
00000053	Windowsill	Natural stone	3	0,9016	1803,276	3	0,14475	12,1725	225,00	237,17
00000054	Windowsill	Natural stone	8	0,4992	998,4	8	0,08025	6,735	600,00	606,74
00000055	Column (round) general	Cast Iron	6	0,0261	188,103	6	0,1425	11,985	4.500,00	4.511,99
00000056	Column (round) general	Cast Iron	2	0,0126	91,066	2	0,069	5,805	1.500,00	1.505,81
00000057	Beam	Wood	8	0	0	8	0	0	150,00	150,00
00000058	Beam	Wood	3	0	0	3	0	0	56,25	56,25
00000059	Beam	Wood	6	0	0	6	0	0	112,50	112,50
00000060	Balustrade	Staal	1	0	0	1	0	0	15,00	15,00
				736,18	**1.119.208,07**		**194,26**	**16.337,01**	**78.530,21**	**94.867,22**

The four rightmost columns show the Co2 savings for each material as a result of avoided production of new materials (see substantiation per material below), the value of these avoided Co2 emissions, the commercial value of the materials (see substantiation below) and the sum of the environmental value (Co2-€) and the commercial/financial value of the materials. We can add up all the values of materials, because a property right has also been created for each material in Cirdax based on a Blockchain registration from the Blockchain module of Digital Deconstruction. This then enables an accountant to add up the value of all these property titles in one business economic balance sheet or total social environmental impact expressed in euros.

The preparation of a social materials balance of a building, as presented in tables 1 and 2, is based on various actions, starting points and the continuous resolution of certain obstacles. In addition, certain issues may not be resolved. If this is the case, the figures for the materials involved will not be included in the social materials balance. Efforts are being made to improve this through further research.

A comparison between tables 1 and 2 shows that the difference between 100% reuse and 75% reuse of the registered materials of the School Berlaar involves a social value difference of approximately 32,000 euros. This also indicates the financial scope for the various service providers to perform their services in such a way that they are also able to safeguard this social value. We assume that the service providers will also be rewarded for the realized Co2 savings from ETS allowances that can be sold. This is not yet possible in practice, but it clearly reflects the social and economic value of these actions.

2. Substantiation of kilos per material

During the inventory, the sizes of the various materials and products that are in the building were measured. Subsequently, the cubic meters of these materials were calculated. By multiplying this by the specific weight, we get the kilograms per material.

For the Berlaar School, in fact, only the materials with a positive value have been inventoried. The other materials are only mentioned in the inventory report, but not further specified. Therefore, all unnamed materials are not included in the overview above.

3. Substantiation of prices per material

The prices of the materials generally look at the value that can now be given for a product. In other words, the price * the amount of materials, after processing to make them ready for reuse. The sum of all materials and their values shape the financial materials balance of a building. This value is often still negative, because the processing costs are higher than the value of the material after this processing.

A distinction can therefore be made between products with a positive value and a negative value. The positive values are regarded as revenues and the negative values as costs. The idea is that a product cannot have a negative value if all transaction costs are not taken into account (which is the case because the processing costs have been deducted from it, since the pure price is unknown). In the Berlaar pilot, all products and materials with a negative value are not included, because they are inventoried in a different way. They do exist in reality, of course, but are not included in this analysis.

Because markets for secondary materials are still very local, setting the prices of materials after processing is based on local knowledge. In the balance sheets above, known prices have been assumed for materials in the Brabant/Antwerp region (NL and BE). So these should be assessed as indicative in this impact analysis.

4. Substantiation of CO2 values per material

The CO2 values used come from the ICE database. This database was compiled by researchers at the University of Bath (UK). The CO2 values of various raw materials have been measured in this database. An attempt was made to map out the cradle-to-gate process of these raw materials. In the following this will be referred to as 'embodied CO2'. The problem here is that some materials seem more CO2-friendly than they are, because it 'costs' little CO2 to make them, but they are not recyclable, for example. This problem can be tackled in subsequent stages by including more phases in this calculation.

Since this database is made from the perspective of the United Kingdom, the values cannot fully correspond to the European situation. If there are major differences, we try to adjust these data to Dutch or European standards. The last version of the database dates from August 9, 2019 and has not been modified since. However, the research is ongoing, so that the Co2 figures can be considered up-to-date.

The values below are stated in kilograms of CO2 per kilogram of material. An indication of the reliability of this value is then added. For each material, we indicate the actual amount of Co2 (kilo Co2 per kilo of material), including an indication of the reliability of this figure. After all, for some materials this issue has hardly ever been investigated, or if the Dutch situation deviates so much from the British situation, further research is more than necessary. Apart from the ongoing study of the University of Bath, many things are still under development. The representation in this document is the current state of affairs in accordance with the ICE database https://circularecology.com/embodied-carbon-footprint-database.html

Aluminium

Value = 8.24

Reliability = High

Aluminum contained in a building material is not 100% new. On average, 1/3 of the aluminum in a building material is recycled. This ensures that the CO2 value is built up from a very CO2 intensive process of excavation and a process of manufacturing the raw material aluminum into a construction product. New aluminum has a value of 11.46 and recycled 1.69. Should the new/recycled ratio change in the future, this can be calculated immediately. There is also hardly any variation between the different types of aluminum.

Concrete

Value = 0.06465

Reliability = Average

The stronger the concrete, the more CO2 is released during its making. This has to do with the fact that the cement mixture in concrete varies greatly between different types. In the Netherlands, compared to the rest of the world, a lot of blast furnace slag is used in this cement mixture. The cement type that is often used is CEM III/A and CEM III/B. On average, the percentage of blast furnace slag is 65% and the clinker content is 35%. This is a lot more environmentally friendly than in the ICE database. Based on a calculation by GreenCem BV, we therefore arrive at a lower value than stated in the database.

Bitumen

Value = 0.42

Reliability = Average

Aerated concrete

Value = 0.3

Reliability = Low

Because this value comes from the ICE database and no Dutch calculations exist, this value may be too high (see the heading Concrete).

Galvanized steel

Value = 1.92

Reliability = average

The CO2 that is released when cutting the steel into blades is not included in the process.

Cast

Value = 0.12

Reliability = average

In the literature, the CO2 value of gypsum was often added to that of cement, which led to larger fluctuations. This somewhat lowers our reliability towards this value.

Glass

Value = 1.41

Reliability = High

With glass, the production process is split into two parts, a primary process (0.86) in which the glass is made, and a secondary process (0.55) in which the glass is cut into the correct sizes. Recycling rates are irrelevant here, as recycled glass is only used for glass packaging and not for building materials.

Wood

Value = -1.03

Reliability = High

Wood is a bio-based material. This means that it grows again after you have already used it once. In addition, wood is a storage place for Co2. Earlier measurements within the ICE database only included the embodied Co2 of wood. In the latest version, this is accompanied by the amount of Co2 absorbed by a kilo of wood over the years. We then speak of the sequestered or absorbed Co2. The value indicated here is therefore the sum of the embodied and sequestered Co2. We will do this for all bio-based materials.

Lime sandstone

Value = 0.76

Reliability = High

Nothing unusual.

Ceramics

Value = 1.51

Reliability = High

In this case, the ceramic materials in the building are sanitary products. As a result, the value is higher than for a generic form of ceramic.

Buyer

Value = 2.6

Reliability = High

As with aluminum, some of the copper is new and some is recycled. This is based on a recycling percentage of 37%. This is in line with European averages.

Plastic

Value = 2.73

Reliability = Average

There are different types of plastic, which makes it difficult to determine which form of plastic is meant here. An average value has been taken as a starting point here.

Linoleum

Value = 1.21

Reliability = Average

Little data available.

PUR (polyurethane)

Value = 3.77

Reliability = Average

Two values are known for PUR, one for flexible foam (4.06) and one for solid (3.48). An average of these two has been taken here.

stainless steel

Value = 6.15

Reliability = High

Steel

Value = 1.37

Reliability = High

As with aluminum, the steel used for building materials is not 100% virgin steel. The European average here is a ratio of 59% recycled steel and 31% virgin steel.

Rockwool

Value = 1.05

Reliability = Average

The value given for stone wool is based on a cradle-to-grave process. For a cradle-to-gate process, the value is at most equal to the above (probably lower).

Wool/nylon/polypropylene

Value = 3.9

Reliability = Low

The problem with determining the value for carpet is that there are big differences depending on the amounts of wool, nylon and polypropylene. This is an average of various types of carpet.

Brick

Value = 0.2130

Reliability = Average

This value is taken from the ICE 3.0. database for bricks. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK.

Concrete/Ceramic/Masonry

Value = 1,000

Reliability = Low

There is no unambiguous raw material here. The value is a weighted equal average of concrete, ceramic and masonry. In practice, these will differ per dismantling work, but a value of 1,000 is a first reasonable estimate.

Tree sand

Value = 0.0170

Reliability = Average

The value for all types of sand reflects the embodied Co2 without further heating. Because tree sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

bronze

Value = 1,100

Reliability = High

Bronze that is in a building material, as is also the case with other metals, is not 100% new. On average, 40-45% of the bronze in a building material is recycled. This ensures that the CO2 value is built up from a very CO2 intensive process of excavation and a process of manufacturing the raw material aluminum into a construction product. New bronze has a value of 3.7 and recycled 1.1. Should the new/recycled ratio change in the future, this can be calculated immediately. Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages.

Cement

Value = 0.8320

Reliability = Average

The value is the average within the UK, in accordance with ICE 3.0. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK.

Chrome

Value = 20,000

Reliability = Low

The value for chromium can only be found in the ICE 2.0. database from 2011 and has only a limited number of findings. Because Chromium is a processed metal, its value is relatively high, but as yet unreliable.

Floating stone

Value = 0.1070

Reliability = Low

Natural stone is a little-researched material, but has a relatively low value, because almost only excavation and logistical activities are associated with the material. Floating stone is considered a natural stone. Further investigation of natural stone is desirable. Stone values are in accordance with ICE 2.0. from 2011.

Plasticized wood

Value = -1,340

Reliability = Average.

The value is the average within the UK, in accordance with ICE 3.0. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK. The value indicated here is the sum of the embodied (+0.6980) and sequestered Co2 (-2.0380).

Cast iron

Value = 1.0100

Reliability = Average

Iron contained in a building material is, as is also the case with other metals, not 100% new. On average, 40-45% of the Iron in a building material is recycled. This ensures that the CO2 value is built up from a very CO2 intensive process of excavation and a process of manufacturing the raw material aluminum into a construction product. New iron has a value of 1.5 and recycled iron has a value of 0.52. Should the new/recycled ratio change in the future, this can be calculated immediately. Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages., pp 463-469.

Glass wool

Value = 0.2780

Reliability = Average

The value is the average within the UK, in accordance with ICE 3.0. (section sand, no. 8). Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK.

Gravel

Value = 0.0170

Reliability = Average

The value for all types of sand and gravel reflects the embodied Co2 without further heating. Because gravel, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Ground

Value = 0.0170

Reliability = Average

The value for all types of sand and soil reflects the embodied Co2 without further heating. Because soil, as with all other types of sand, is subject to various treatments, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Hardboard

Value = -0.8200

Reliability = Average.

The value is the average within the UK, in accordance with ICE 3.0. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK. The value indicated here is the sum of the embodied (+0.8200) and sequestered Co2 (-1.6400).

Wood wool and cement

Value = 0.8500

Reliability = Low

There is no unambiguous raw material here. The value is a weighted equal average of wood wool and cement. In practice, these will differ per disassembly work, but a value of 0.8500 is a first reasonable estimate.

Iron

Value = 1.0100

Reliability = Average

Iron contained in a building material is, as is also the case with other metals, not 100% new. On average, 40-45% of the Iron in a building material is recycled. This ensures that the CO2 value is built up from a very CO2 intensive process of excavation and a process of manufacturing the raw material aluminum into a construction product. New iron has a value of 1.5 and recycled iron has a value of 0.52. Should the new/recycled ratio change in the future, this can be calculated immediately. Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages., pp 463-469.

Lime sandstone

Value = 0.7600

Reliability = High

Nothing unusual.

Ceramic material

Value = 1.5100

Reliability = High

Equivalent to the value of ceramics

Clay

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because clay, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Coconut

Value = 0.0000

Reliability = Low

Coconut is a bio-based building material. Little research has been done on it.
https://www.wur.nl/nl/show/Building-material-from-waste-coconut.htm

Cork

Value = 0.1900

Reliability = Low

The value is the average within the UK, in accordance with ICE 2.0. for embodied Co2. The sequestered Co2 is not yet known. The total value for cork may therefore be lower.

Loam

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because loam, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Light concrete

Value = 0.6500

Reliability = High

According to concrete.

Lead

Value = 1.64

Reliability = Average

Lead that is in a building material, as is also the case with other metals, is not 100% new. On average, 30% of the lead in a building material is recycled. This ensures that the CO2 value is built up from a very CO2 intensive process of excavation and a process of manufacturing the raw material aluminum into a construction product. New lead has a value of 2.61 and recycled 0.53. Should the new/recycled ratio change in the future, this can be calculated immediately. Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages, p. 479.;

Loess

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because loess, as with all other types of sand, involves various operations, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Mixing granulate

Value = 0.0647

Reliability = Low

In accordance with concrete as a material. Still unknown as a mixture product for new concrete, but that has an influence on the value of concrete as a mixture of old and new concrete, just as it applies to metals. The reliability can therefore be further improved.

Mixing debris

Value = 1,300

Reliability = Low

Valued as a mixture between brick and concrete, but also depends on the composition. The reliability can therefore be further improved.

Mixture of stone

Value = 0.2130

Reliability = Low

In accordance with brick as a material. As a mixed product for new bricks still unknown, but that has an influence on the value of brick as a mixture of old and new brick, just as it applies to metals. The reliability can therefore be further improved.

Brass

Value = 2,400

Reliability = High

Brass that is in a building material, as is also the case with other metals, is not 100% new. On average, 41-45% of the brass in a building material is recycled. This ensures that the CO2 value is built up from a very CO2 intensive process of excavation and a process of manufacturing the raw material aluminum into a construction product. New brass has a value of 3.7 and recycled 1.06. Should the new/recycled ratio change in the future, this can be calculated immediately. Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages., p 477.

Masonry sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because masonry sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Natural stone

Value = 0.1070

Reliability = Low

Natural stone is a little-researched material, but has a relatively low value, because almost only excavation and logistical activities are associated with the material. Floating stone is considered a natural stone. Further investigation of natural stone is desirable. Stone values are in accordance with ICE 2.0. from 2011.

Fill sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because fill sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Paper

Value = 1.1500

Reliability = High

Sources:

Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages, p. 481.

Conservatree.org <www.conservatree.com/learn/EnviroIssues/TreeStats.shtml>

Thompson, C., 1992: *Recycled Papers - The Essential Guide* , MIT Press, Cambridge, MA, 200 pages. Quoted by <conservatree.org/learn/EnviroIssues/TreeStats.shtml>

Poriso

Value = 0.2130

Reliability = Average

Conform brick.

River sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because river sand, as with all other types of sand, undergoes various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Rubber

Value = 2,100

Reliability = average

Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages, p. 481., chapter 15.

Stone

Value = 0.1070

Reliability = Low

Natural stone is a little-researched material, but has a relatively low value, because almost only excavation and logistical activities are associated with the material. Floating stone is considered a natural stone. Further investigation of natural stone is desirable. Stone values are in accordance with ICE 2.0. from 2011.

Street sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because paving sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Tar/asphalt

Value = 0.043

Reliability = Average

This value is taken from the ICE 3.0. database for Asphalt. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK.

tarry

Value = 0.043

Reliability = Average

This value is taken from the ICE 3.0. database for Asphalt. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK.

Peat

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel, peat and clay reflects the embodied Co2 without further heating. Because peat, as with all other types of soil, is sand subject to various treatments, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed. Peat is a special raw material for other reasons, because a lot of stored Co2 is released from the peat when the groundwater level changes. We have not included this aspect of embodied Co2 here, because these Co2 emissions are not related to the production of this raw material for construction, but are emitted for geological reasons.

Preserved wood

Value = -1.2900

Reliability = Average.

The value is the average within the UK, in accordance with ICE 3.0. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK. The value indicated here is the sum of the embodied (+0.3000) and sequestered Co2 (-1.5900).

Fiber concrete

Value = 0.0800

Reliability = Average.

In accordance with concrete, but an addition through the fibres.

Vinyl

Value = 2.2900

Reliability = Average.

Stone values are in accordance with ICE 2.0. from 2011.

Flax

Value = -0.0001

Reliability = Low

The value indicated here is the sum of the embodied (+1,400) and sequestered Co2 (-1,400). The studies into this bio-based material are extremely modest. More research is needed, which is why the reliability is still low.

grout sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because joint sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Fill sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because filling sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

White sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because white sand, as with all other types of sand, involves various processes, the value here has been set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Softboard

Value = -1.2900

Reliability = Average.

The value is the average within the UK, in accordance with ICE 3.0. Because this reflects the UK situation, the reliability for the Dutch situation is considered to be average. This is high for the UK. The value indicated here is the sum of the embodied (+0.2600) and sequestered Co2 (-1.5500).

Sand

Value = 0.0170

Reliability = Average

The value for all types of sand, gravel and clay reflects the embodied Co2 without further heating. Because sand involves various processes, the value here is set to be the average of all types of sand, as in the ICE 3.0. has been displayed.

Zinc

Value = 2.7918

Reliability = High

Zinc contained in a building material is, as is also the case with other metals, not 100% new. On average, 21-25% of the bronze in a building material is recycled. This ensures that the CO2 value is built up from a very CO2-intensive process of mining and a process of manufacturing the raw material zinc into a construction product. New zinc has a value of 3.3 and recycled 0.88. Should the new/recycled ratio change in the future, this can be calculated immediately. Source: Ashby, MF, 2013: Materials and the Environment – Eco - Informed Material Choice, 2nd ed., Butterworth - Heinemann, 616 pages, p. 481.