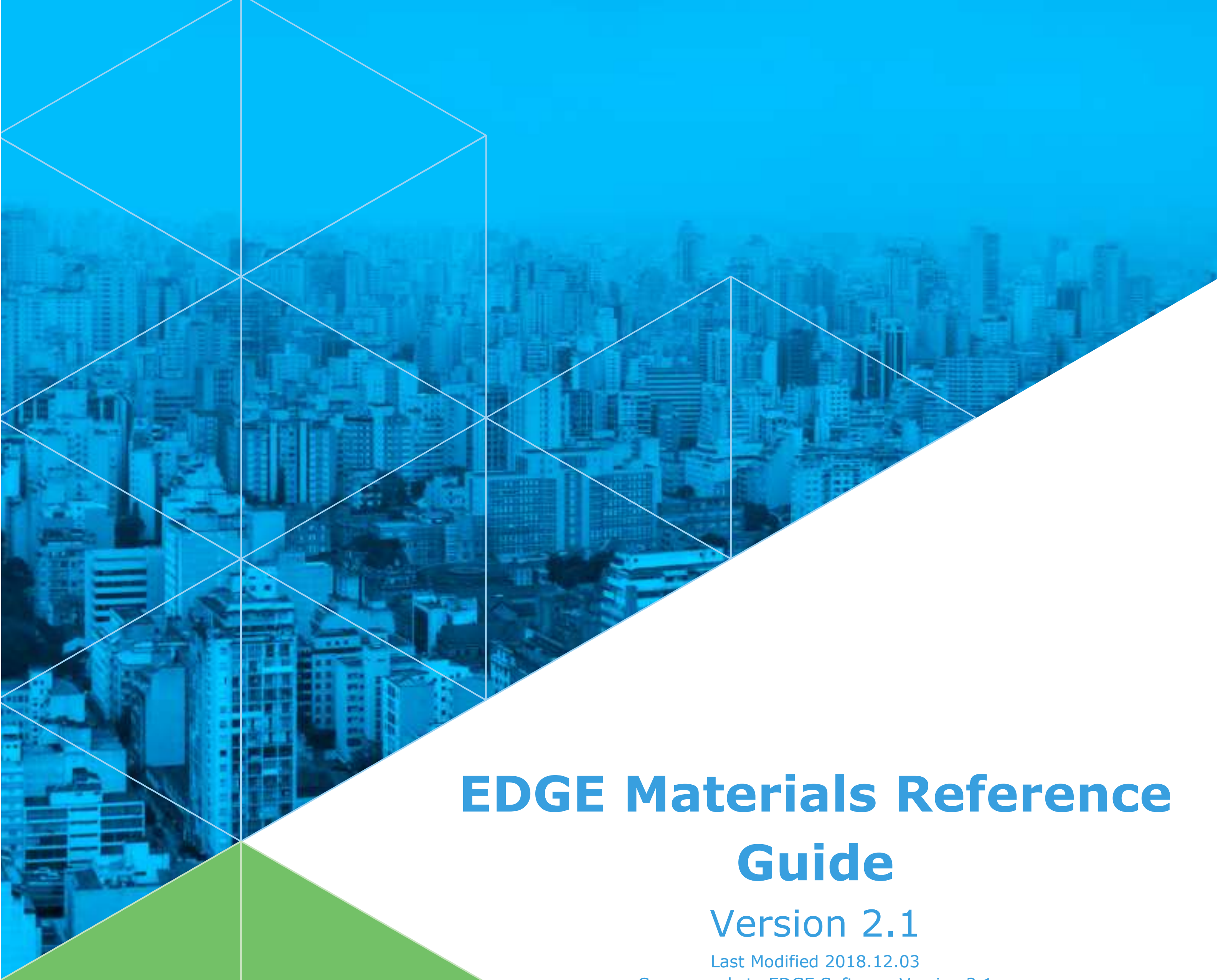

EDGE Materials Reference Guide

Version 2.1

Last Modified 2018.12.03
Corresponds to EDGE Software Version 2.1
For All Building Types

Excellence In Design For Greater Efficiencies

International Finance Corporation
WORLD BANK GROUP

Creating Markets, Creating Opportunities

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INTRODUCTION

About the EDGE Materials Reference Guide

The EDGE Materials Reference Guide is a companion volume to the EDGE User Guide version 2.1. This Reference Guide contains the complete list of materials available in EDGE, and details on their respective embodied energy.

About EDGE ("Excellence in Design for Greater Efficiencies")

EDGE is a green buildings platform that includes a green building standard, a software application, and a certification program for more than 150 countries. The platform is intended for anyone who is interested in the design of a green building, whether an architect, engineer, developer or building owner.

EDGE empowers the discovery of technical solutions at the early design stage to reduce operational expenses and environmental impact. Based on the user's information inputs and selection of green measures, EDGE reveals projected operational savings and reduced carbon emissions. This overall picture of performance helps to articulate a compelling business case for building green.

The suite of EDGE building types includes Homes, Hospitality, Retail, Offices, Hospitals, and Education buildings. EDGE can be used to certify buildings at any stage of their life cycle; this includes concept, design, new construction, existing buildings, and renovations.

An Innovation of IFC

EDGE is an innovation of IFC, a member of the World Bank Group.

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CHANGE LOG

V2.1

This is the first version of the EDGE Materials Reference Guide for all EDGE buildings. It was formerly included as an Appendix in the older versions of the User Guides (version 2.0 and 1.0); it has now been made available separately to accompany the latest version of the combined EDGE User Guide (version 2.1). The list of materials and their details have been updated to reflect the current data being used in the EDGE software application.

DETAILED LIST OF MATERIALS

This Reference Guide provides details on the options for Materials available in the EDGE software. The details include:

- Description of the material or construction technique supported with a visual swatch
- List of key components of that Material or assembly
- Constraints such as minimum and maximum thickness, and the default thickness
- Embodied Energy of the material or construction assembly

Where a value is not applicable, it is omitted. For instance, the EDGE software does not utilize the thickness of windows in its calculations. Therefore, thickness values are omitted for windows.

Embodied Energy is the environmental impact of a material product or assembly expressed in the form of energy that is consumed in the production of a material product or assembly in its journey from the original source to the final product which then becomes an integral part of it. The environmental impacts due to the extraction, refining, processing, transportation, and fabrication of construction products count towards their embodied energy.

The environmental impacts of materials vary depending on where and how they are manufactured and used. In determining the embodied environmental impacts of a given building, the EDGE software uses data on construction materials from the EDGE Emerging Economies Construction Dataset (the "EDGE Dataset"). This dataset has been custom-produced based on a life cycle assessment (LCA) model for the EDGE program through a study commissioned by IFC. The methodology used to generate this dataset is available on the EDGE program website as a Technical Methodology document called the EDGE Materials Embodied Energy Methodology & Results Report Version 2.2.

Due to the global scope of EDGE, incorporating local impact data for materials in all locations is not yet possible. Instead, a targeted and phased approach has been adopted that initially provides a single global EDGE Dataset for the embodied energy of construction materials for all locations. Future phases will provide datasets for specific countries for use in national implementations of EDGE, which may also consider using carbon dioxide (global warming potential) as an indicator of materials efficiency as this more closely reflects the impact of the building on the environment.

The following pages contain the details of each material available as an option in the EDGE software under the Materials category.

M01 – FLOOR SLABS

Following is a list of the floor slab options included in EDGE. The user must always try to select the specification that most closely resembles that of the building design.

1.01 - In-Situ Reinforced Concrete Slab

Description

One of the most popular and conventional floor slab construction types, this floor slab uses Portland cement, sand, aggregate, water, and reinforcing steel.

The thickness of this slab should be measured from the top of the structural slab to the bottom of the slab including the plaster finish. Do not include the layer of cement screed used to level the slab before laying the flooring finish.

Components:

Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.350* m
Maximum thickness	0.350 m
Default reinforcement	35.0* kg / m^2
Embodied energy at default thickness	1,148 MJ/m^2

* Exception: The default thickness of floor slab for Homes is 0.300 m, and the default reinforcement for the floor slab for Homes is 33.0 kg/m^2

1.02 - In-Situ Concrete with >25% GGBS

Description

Ground granulated blast-furnace slag (GGBS) is obtained by quenching molten iron slag (a by-product of iron and steel manufacture) from the blast furnace in water or steam, producing a glassy, granular product which is then dried and ground into a fine powder.

The roof construction technology for GGBS is the same as for the in-situ reinforced concrete slab but the Portland cement is directly replaced by industrial waste (GGBS) on a one-to-one basis by weight. Replacement levels of GGBS vary from 30% to up to 85% as applicable. Typically 40% to 50% of GGBS is used.

Since the manufacture of Portland cement is energy intensive, replacing it with GGBS helps to reduce high-embodied energy content. Using GGBS also helps to reduce air and water pollution, leading to more sustainable roof construction.

Components:

25% GGBS concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.250 m
Default reinforcement	20.0 kg / m^2
Embodied energy at default thickness	595 MJ/m^2

1.03 - In-Situ Concrete with >30% PFA

Description

Pulverized fuel ash (PFA), also known as fly ash, is a waste product of coal fired at power stations. Using PFA as a cement replacement significantly reduces the overall carbon footprint of the concrete construction and helps to reduce risk of air and water pollution. In the advancement of environmental sustainability, PFA usage is one of the most highly recommended construction practices.

Components:

30% PFA Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.250 m
Default reinforcement	20.0 kg / m^2
Embodied energy at default thickness	605 MJ/m^2

1.04 - Concrete Filler Slab

Description

Filler slab construction is technology based on the principal of using filler materials such as brick, clay tiles, and cellular concrete blocks instead of concrete. The filler materials are used in the lower tensile region of the slab, which needs only enough concrete to hold the steel reinforcement together.

Filler slab uses less concrete as well as steel due to the lightweight quality of the slab. It is also more cost-effective compared to conventional in-situ reinforced concrete slab.

Components:

- Concrete
- Hollow filler blocks
- Steel reinforcement
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.300 m
Default reinforcement	11.0 kg / m^2
Embodied energy at default thickness	471 MJ/m^2

1.05 - Precast RC Planks and Joist System

Description

This system uses precast reinforced concrete (RC) elements to construct intermediate floors and consists of two elements:
the Plank, which represents smaller sections of the slab and is therefore of reduced thickness and reinforcement, and
the Joist, which is a reinforced beam spanning across the room to provide support for the planks. The joist is partially precast, with the remaining portion being cast in-situ after the planks are installed.

The planks are supported over the partially precast joists, which are set side by side, and then joined together by pouring in-situ concrete over the entire roofing area. The monolithic quality of the slab is enhanced by leaving reinforcement hooks projecting out of the joists and providing nominal reinforcement over the planks, before the in-situ concrete is poured. Both elements of the floor – planks and joists – can be manually produced at the site using wooden moulds. This method of construction saves time.

Components:

Concrete

Precast concrete flooring panels

Steel reinforcement for panels and joists

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.120 m
Maximum thickness	0.200 m
Default reinforcement	12.0 kg / m^2
Embodied energy at default thickness	470 MJ/m^2

1.06 - Concrete Filler Slab with Polystyrene Insulation

Description

This system is similar to concrete filler slab technology in that one of the aims is to reduce the volume of concrete required, which is more cost-effective compared to conventional in-situ reinforced concrete slab. It is comprised of precast concrete beams, a polystyrene form which then stays in place, in the lower tensile region of the slab and in-situ concrete.

This system can be installed with or without insulation. Adding insulation to the floor slabs that are exposed to outdoor or unconditioned area helps to improve thermal performance for heat gain and loss and reduces the heating/cooling energy demand of the building. If Concrete Filler Slab with Polystyrene Insulation is selected in the Materials section, the embodied energy due to the insulation is added to the floor slab and not to the insulation. The embodied energy of the polystyrene insulation built into the slab is included in the values shown in the table.

Components:

- Concrete
- Expanded polystyrene insulation (EPS)
- Steel reinforcement
- Plaster finish

Minimum thickness	0.150 m
Default thickness	0.200 m
Maximum thickness	0.300 m
Default reinforcement	11.0 kg / m^2
Embodied energy at default thickness	536 MJ/m^2

1.07 - In-Situ Trough Concrete Slab

Description

This system is similar to concrete filler slab technology in that one of the aims is to reduce the volume of concrete required, which makes it more cost-effective compared to conventional in-situ reinforced concrete slab. It is comprised of in-situ concrete troughs formed using removable void formers cast into the lower tensile region of the slab. The void formers are removed on completion.

The thickness of this slab should be measured from the top of the structural slab (excluding the flooring screed), to the bottom of the web.

Components:

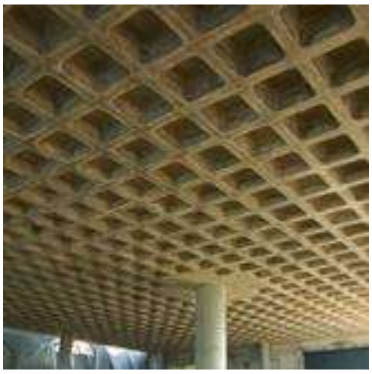
Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.225 m
Default thickness	0.300 m
Maximum thickness	0.600 m
Default reinforcement	12.5 kg / m^2
Embodied energy at default thickness	434 MJ/m^2

1.08 - In-Situ Waffle Concrete Slab



Description

This system is similar to concrete filler slab technology in that one of the aims is to reduce the volume of concrete required, which makes it more cost-effective compared to conventional in-situ reinforced concrete slab. It is comprised of in-situ concrete using removable void formers cast into the lower tensile region of the slab. The void formers are removed on completion.

Components:

Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.350 m
Default thickness	0.350 m
Maximum thickness	0.650 m
Default reinforcement	13.1 kg / m^2
Embodied energy at default thickness	568 MJ/m^2

1.09 - Hollow Core Precast Slab

Description

Hollowcore floor planks are precast concrete elements with continuous longitudinal voids providing an efficient lightweight section.

When grouted, the effective shear key between adjacent Hollowcore planks ensures that the system behaves similarly to a monolithic slab. Hollowcore planks may be used to produce a diaphragm to resist horizontal forces, either with or without a structural topping. Hollowcore planks, supported on masonry or steel can be used in domestic, commercial and industrial applications.

Components:

Precast concrete sections

In-situ concrete topping plus infill at joints

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.350 m
Default reinforcement	15.0 kg / m^2
Embodied energy at default thickness	760 MJ/m^2

1.10 - Composite slim slabs with Steel I-beams

Description

A slim floor is a system of precast, hollow core concrete units or deep composite steel decking supported on modified steel beams in the form of an asymmetric section with a wider bottom flange or a flat steel plate welded to the bottom flange of a standard UKC section. The beam becomes partially encased within the floor depth, resulting in a structural system with no down-stand beams, which leads to reduced floor-to-floor heights. The floor slab supports in-situ concrete that is placed level with or above the top flange of the beam.

Components:

Precast concrete sections

Steel beams (supporting structure not counted in embodied energy calculations)

In-situ concrete topping plus infill at joints

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.350 m
Default reinforcement	19.0 kg / m^2
Embodied energy at default thickness	548 MJ/m^2

1.11 - Composite in-situ concrete and steel deck (permanent shuttering)

Description

Composite slabs comprised of reinforced concrete cast on top of profiled steel decking, which acts as formwork during construction and external reinforcement at the final stage. Additional reinforcing bars may be placed in the decking troughs, particularly for deep decking. They are sometimes required in shallow decking when heavy loads are combined with high periods of fire resistance.

Components:

- In-situ concrete topping plus infill at joints
- Steel reinforcement
- Corrugated galvanized steel sheets
- Ceiling board
- Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.150 m
Default reinforcement	10.0 kg / m^2
Embodied energy at default thickness	407 MJ/m^2

1.12 - Precast concrete double tee floor units

Description

Double Tee units reduce the number of pieces to erect and minimize the number of connections between beams and columns.

Double tees provide a safe, unobstructed work platform, immediately after erection, that is usable for light construction loads.

Reinforced, cast-in-place concrete topping over the double tees provides a leveling course, proper drainage slopes, and a structural floor diaphragm.

Components:

Precast slab and beam

In-situ concrete topping

Steel reinforcement

Plaster finish

Minimum thickness	0.350 m
Default thickness	0.350 m
Maximum thickness	0.800 m
Default reinforcement	10.8 kg / m^2
Embodied energy at default thickness	567 MJ/m^2

1.13 - Thin precast concrete deck and composite in-situ slab

Description

The most common type of composite beam is one where a composite slab sits on top of a downstand beam, connected by the use of a through deck welded shear studs. This form of construction offers a number of advantages - the decking acts as external reinforcement at the composite stage, and during the construction stage as formwork and a working platform. It may also provide lateral restraint to the beams during construction. The decking is lifted into place in bundles, which are then distributed across the floor area by hand. This dramatically reduces the crane lifts when compared with a precast based alternative.

Components:

Precast slab and beam

In-situ concrete topping

Steel reinforcement

Steel girders (supporting structure not counted in embodied energy calculations)

Plaster finish

Minimum thickness	0.120 m
Default thickness	0.120 m
Maximum thickness	0.300 m
Default reinforcement	10.0 kg / m^2
Embodied energy at default thickness	496 MJ/m^2

1.14 - Timber floor construction

Description

Timber floor construction is generally supported on timber joists. These joists are rectangular sections of solid timber spaced at regular intervals, built into the external wall. The covering to the floor is generally timber floorboards or sheet chipboard. The finish to the underside is generally sheet plasterboard. Joist hangers have become very common as the method of supporting the joist, avoiding building joists into walls. These are formed from galvanised steel and effectively form a shoe or seat for the joist to fit into, this then being built into the wall. They are also very useful for junctions between joists where previously a complicated carpentry joint would have been required.

Components:

Plywood floor deck

Timber studs

Ceiling board

Plaster skim coat

Minimum thickness	0.250 m
Default thickness	0.250 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	291 MJ/m^2

1.15 - Light gauge steel floor cassette

Description

Pre-assembled sheet steel floor cassettes are manufactured off-site to stringent factory tolerances and can be bolted into the structure as a complete unit, providing a secure platform that can take a load straight away. This significantly speeds up the building process and ensures precise accuracy.

Components:

In-situ concrete topping

Steel reinforcement

Steel casette

Steel supporting frame (supporting structure not counted in embodied energy calculations)

Ceiling board

Plaster skim coat

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.300 m
Default reinforcement	2.5 kg / m^2
Embodied energy at default thickness	556 MJ/m^2

1.16 – Re-use of existing floor slab

Description

Re-using an existing material avoids the use and therefore, embodied energy, of new materials. The re-use of existing materials option in EDGE is highly desirable and assigned an embodied energy value of zero (0). Materials greater than five years old will be considered as embodied-energy neutral, which can be indicated as "re-use of existing materials" within the EDGE App.

Components:	Embodied energy at default thickness	
Re-use of existing floor slab		0 MJ/m^2

M02 – ROOF CONSTRUCTION

2.01 - In-Situ Reinforced Concrete Slab

Description

One of the most popular and conventional floor slab construction types, this floor slab uses Portland cement, sand, aggregate, water, and reinforcing steel.

Components:

Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.350 m
Maximum thickness	0.350 m
Default reinforcement	35.0 kg / m^2
Embodied energy at default thickness	1,148 MJ/m^2

2.02 - In-Situ Concrete with >25% GGBS

Description

Ground granulated blast-furnace slag (GGBS) is obtained by quenching molten iron slag (a by-product of iron and steel making) from the blast furnace in water or steam, producing a glassy, granular product which is then dried and ground into a fine powder. EDGE estimates the embodied energy based on a 200mm thickness.

The roof construction technology for GGBS is the same as for the in-situ reinforced concrete slab but the Portland cement is directly replaced by industrial waste (GGBFS) on a one-to-one basis by weight. Replacement levels of GGBS vary from 30% to up to 85% as applicable. In most instances typically 40% to 50% of GGBS is used.

Since the manufacture of Portland cement is energy intensive, replacing it with GGBS helps to reduce high-embodied energy content. Using GGBS also helps to reduce air and water pollution, leading to a more sustainable roof construction practice.

Components:

25% GGBS mixed concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.250 m
Default reinforcement	20.0 kg / m^2
Embodied energy at default thickness	619 MJ/m^2

2.03 - In-Situ Concrete with >30% PFA

Description

Pulverized fuel ash (PFA), also known as fly ash, is a waste product of coal fired at power stations. Using PFA as a cement replacement significantly reduces the overall carbon footprint of the concrete construction and helps to reduce risk of air and water pollution. In the promotion of environmental sustainability, PFA usage is one of the most highly recommended construction practices.

Components:

30% PFA mixed concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.250 m
Default reinforcement	20.0 kg / m^2
Embodied energy at default thickness	605 MJ/m^2

2.04 - Concrete Filler Slab

Description

Filler slab construction is technology based on the principal of using filler materials such as brick, clay tiles, and cellular concrete blocks instead of concrete. The filler materials are used in the lower tensile region of the slab, which needs only enough concrete to hold the steel reinforcement together.

Filler slab uses less concrete as well as steel due to the lightweight quality of the slab. It is also more cost-effective compared to conventional in-situ reinforced concrete slab.

Components:

Concrete

Hollow filler blocks

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.300 m
Default reinforcement	11.0 kg / m^2
Embodied energy at default thickness	471 MJ/m^2

2.05 - Precast RC Planks and Joist System

Description

This system uses precast concrete elements to construct intermediate floors and consists of two elements:

The plank, which represents smaller sections of the slab and is therefore of reduced thickness and reinforcement, and

The joist, which is a beam spanning across the room to provide a bearing for the planks. The joist is partially precast, with the remaining portion being cast in-situ after the planks are installed.

The monolithic action of the slab elements is enhanced by leaving reinforcement hooks projecting out of the joists and providing nominal reinforcement over the planks, before the in-situ concrete is poured. The planks are supported over partially precast RC joists which are set side by side and then joined together by pouring in-situ concrete over the entire roofing area. Both elements of the floor – planks and joists – can be manually produced at the site using wooden moulds. This method of construction saves time.

EDGE estimates the embodied energy based on a 150mm thickness.

Components:

Precast concrete planks and joists

In-situ concrete topping and infill in joints

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.120 m
Maximum thickness	0.200 m
Default reinforcement	12.0 kg / m^2
Embodied energy at default thickness	470 MJ/m^2

2.06 - Concrete Filler Slab with Polystyrene Insulation

Description

This system is similar to concrete filler slab technology in that one of the aims is to reduce the volume of concrete required, which is more cost-effective compared to conventional in-situ reinforced concrete slab. It is comprised of precast concrete beams, a polystyrene form which then stays in place, in the lower tensile region of the slab and in-situ concrete.

This system can be installed with or without insulation. Adding insulation to the roof slabs helps to improve thermal performance for heat gain and loss. Using insulation reduces the heating/cooling energy demand of the building. If Concrete Filler Slab with Polystyrene Insulation is selected in the Materials section, the embodied energy due to the insulation is added to the roof slab and not to the insulation. The embodied energy of the polystyrene insulation built into the slab is included in the values shown in the table.

Components:

- Precast concrete beams
- Expanded polystyrene insulation (EPS)
- Steel reinforcement
- Plaster finish

Minimum thickness	0.150 m
Default thickness	0.200 m
Maximum thickness	0.300 m
Default reinforcement	11.0 kg / m^2
Embodied energy at default thickness	527 MJ/m^2

2.07 - In-Situ Trough Concrete Slab

Description

This system is similar to concrete filler slab technology in that one of the aims is to reduce the volume of concrete required, which is more cost-effective compared to conventional in-situ reinforced concrete slab. It is comprised of in-situ concrete troughs formed using removable void formers cast into the lower tensile region of the slab. The void formers are removed on completion.

Components:

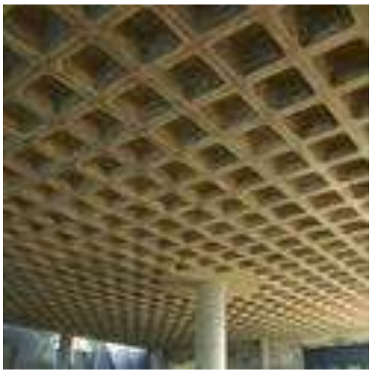
Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.225 m
Default thickness	0.300 m
Maximum thickness	0.600 m
Default reinforcement	12.5 kg / m^2
Embodied energy at default thickness	434 MJ/m^2

2.08 - In-Situ Waffle Concrete Slab



Description

This system is similar to concrete filler slab technology in that one of the aims is to reduce the volume of concrete required, which is more cost-effective compared to conventional in-situ reinforced concrete slab. It is comprised of in-situ concrete waffles formed using removable void formers cast into the lower tensile region of the slab. The void formers are removed on completion.

Components:

Concrete

Steel reinforcement

Plaster finish

Minimum thickness	0.350 m
Default thickness	0.350 m
Maximum thickness	0.650 m
Default reinforcement	13.1 kg / m^2
Embodied energy at default thickness	568 MJ/m^2

2.09 - Hollow Core Precast Slab

Description

Hollow core floor planks are precast concrete elements with continuous longitudinal voids providing an efficient lightweight section.

When grouted, the effective shear key between adjacent Hollow core planks ensures that the individual planks behave similarly to a monolithic slab. Hollow core planks may be used to produce a diaphragm to resist horizontal forces, either with or without a structural topping. Hollow core planks, supported on masonry or steel can be used in domestic, commercial and industrial applications.

Components:

Precast concrete sections

In-situ concrete topping plus infill at joints

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.350 m
Default reinforcement	10.9 kg / m^2
Embodied energy at default thickness	708 MJ/m^2

2.10 - Composite slim slabs with Steel I-beams

Description

A slim beam is a modified steel section in the form of a rolled asymmetric section (ASB beam) or a flat steel plate welded to the bottom flange of a standard UKC section. The bottom plate supports the roof slab so that the beam is partially encased within the roof depth, resulting in a structural system with no down-stand beams, which leads to reduced floor-to-floor heights. The slab may be in the form of precast, hollow core concrete units or deep composite steel decking, in both cases supporting in-situ concrete that is placed level with or above the top flange of the beam.

Components:

Precast concrete sections

In-situ concrete topping plus infill at joints

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.350 m
Default reinforcement	14 kg / m^2
Embodied energy at default thickness	480 MJ/m^2

2.11 - Composite in-situ concrete and steel deck (permanent shuttering)

Description

Composite slabs comprise reinforced concrete cast on top of profiled steel decking, which acts as formwork during construction and external reinforcement at the final stage. Additional reinforcing bars may be placed in the decking troughs, particularly for deep decking. They are sometimes required in shallow decking when heavy loads are combined with high periods of fire resistance.

Components:

In-situ concrete topping plus infill at joints

Steel reinforcement

Corrugated galvanized steel sheets

Ceiling board

Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.150 m
Default reinforcement	10.0 kg / m^2
Embodied energy at default thickness	395 MJ/m^2

2.12 - Precast concrete double tee roof units

Description

Combined beam/column frame units reduce the number of pieces to erect and minimize the number of connections between beams and columns.

Double tees provide a safe, unobstructed work platform, immediately after erection, that is usable for light construction loads.

Reinforced, cast-in-place concrete topping over the double tees provides a leveling course, proper drainage slopes, and a structural floor diaphragm.

Components:

Precast slab and beam

In-situ concrete topping

Steel reinforcement

Plaster finish

Minimum thickness	0.350 m
Default thickness	0.350 m
Maximum thickness	0.800 m
Default reinforcement	10.8 kg / m^2
Embodied energy at default thickness	592 MJ/m^2

2.13 - Thin precast concrete deck and composite in-situ slab

Description

This construction technique utilizes a composite beam, that is a structural beam composed of different materials that are interconnected so that the beam responds to loads as a unit. The most common type of composite beam is one where a steel-concrete composite slab sits on top of a downstand beam, connected by the use of through-deck welded shear studs. This form of construction offers a number of advantages - the decking acts as external reinforcement at the composite stage, and during the construction stage as formwork and a working platform. It may also provide lateral restraint to the beams during construction. The decking is lifted into place in bundles, which are then distributed across the floor area by hand. This dramatically reduces the crane lifts when compared with a precast alternative.

Components:

Precast slab and beam

In-situ concrete topping

Steel reinforcement

Steel girders

Plaster finish

Minimum thickness	0.120 m
Default thickness	0.120 m
Maximum thickness	0.300 m
Default reinforcement	10.0 kg / m^2
Embodied energy at default thickness	1027 MJ/m^2

2.14 - Brick Panel Roofing System

Description

A brick roofing panel is made of first class bricks reinforced with two mild steel bars of 6mm diameter. The joints between panels are filled with either 1:3 cement sand mortar or M15 concrete. The panels are typically 530mm x 900mm or 530mm x 1200mm, depending on the requirements. The recommended maximum length is 1200 mm.

Components:

Brick

Steel beams

In-situ concrete topping

Plaster finish

Minimum thickness	0.150 m
Default thickness	0.150 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1,544 MJ/m^2

2.15 - Ferro Cement Roofing Channels

Description

Ferro cement is a thin layer of reinforced cement, made of layers of continuous mesh covered on both sides with mortar. Ferro cement elements are durable, versatile, light and waterproof. They are not good thermal insulators. A ferro cement channel (FC) is a longitudinal element of a curved section (often semi-cylindrical). It is precast using moulds. It uses less cement and steel but has the same strength as RCC (reinforced cement concrete). This system is cheaper than RCC. Although it is easy to learn and to manufacture, constant quality control is needed during the manufacturing process.

Components:

Precast ferro-concrete panels

Steel reinforcement

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	15.0 kg / m^2
Embodied energy at default thickness	730 MJ/m^2

2.16 - Clay Roofing Tiles on Steel Rafters

Description

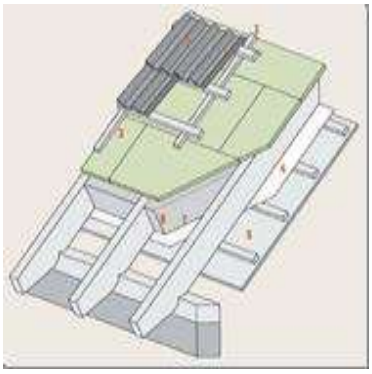
In this type of roof construction, clay tiles are laid on steel or timber rafters. Steel rafters ensure durability and strength but the embodied energy content of steel is relatively high. Timber rafters need maintenance but have less embodied energy. Timber should be sourced from a responsible forest management agency or from re-growth forests to ensure the protection and conservation of natural forest communities. EDGE estimates the embodied energy based on a thickness of 10mm for the clay roofing tiles and 8mm for the steel or timber rafters.

Components:

- Clay roofing tiles
- Steel rafters
- Ceiling board
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	373 MJ/m^2

2.17 - Clay Roofing Tiles on Timber Rafters



Description

In this type of roof construction, clay tiles are laid on steel or timber rafters. Steel rafters ensure durability and strength but the embodied energy content of steel is relatively high. Timber rafters need maintenance but have less embodied energy. Timber should be sourced from a responsible forest management agency or from re-growth forests to ensure the protection and conservation of natural forest communities. EDGE estimates the embodied energy based on a thickness of 10mm for the clay roofing tiles and 8mm for the steel or timber rafters.

Components:

- Clay roofing tiles
- Timber rafters
- Ceiling board
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	244 MJ/m^2

2.18 - Micro Concrete Tiles on Steel Rafters

Description

Micro Concrete Roofing (MCR) Tiles are small-sized concrete tiles that can be used as an alternate to clay tiles, with less embodied energy content than clay roof tiles. They are light-weight and can be laid on a lighter weight structure. They have the strength of concrete and can be pigmented to any desired color. This makes MCR a cost-effective, aesthetic, and durable alternative sloping roof technology. They are also brittle and must be handled with care while laying the tiles.

Components:

Cement tiles

Steel angles

Ceiling board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	239 MJ/m^2

2.19 - Micro Concrete Tiles on Timber Rafters

Description

Micro Concrete Roofing (MCR) Tiles are small-sized concrete tiles that can be used as an alternate to clay tiles, with less embodied energy content than clay roof tiles. They are light-weight and can be laid on a lighter weight structure. They have the strength of concrete and can be pigmented to any desired color. This makes MCR a cost-effective, aesthetic, and durable alternative sloping roof technology. They are also brittle and must be handled with care while laying the tiles.

Components:

Cement tiles

Timber rafters

Ceiling board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	110 MJ/m^2

2.20 - Steel (zinc or galvanised iron) Sheets on Steel Rafters

Description

Steel is one of the strongest and most affordable materials. It is a ferrous metal, that is, it contains iron. It has a favorable strength-to-weight ratio and provides elasticity. Other benefits include stiffness and fire and corrosion resistance.

Steel roof profiles create economical solutions in both new building and renovation and in operating and maintenance. The profiles come in a very broad range of shapes, finishing, and colors that enable innovative designs. In addition, they can be installed with insulation for better thermal performance.

Components:

- Thin steel sheet
- Steel angles
- Ceiling board
- Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	444 MJ/m^2

2.21 - Steel (zinc or galvanised iron) Sheets on Timber Rafters

Description

Steel is one of the strongest and most affordable materials. It is a ferrous metal, that is, it contains iron. It has a favorable strength-to-weight ratio and provides elasticity. Other benefits include stiffness and fire and corrosion resistance.

Steel roof profiles create economical solutions in both new building and renovation and in operating and maintenance. The profiles come in a very broad range of shapes, finishing, and colors that enable innovative designs. In addition, they can be installed with insulation for better thermal performance.

Components:

- Thin steel sheet
- Timber rafters
- Ceiling board
- Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	371 MJ/m^2

2.22 - Aluminium sheets on Steel Rafters

Description

Besides steel, aluminium is the most commonly used metal in construction. It is one of the lightest and easiest metals to manipulate, bend, shape, cast, fasten, and weld, and is also very ductile, often extruded into shapes for architectural purposes. It can easily be drilled, tapped, sawed, planed, and filed with hand tools, making it a yielding material for tradesmen to use. Aluminium has higher resistance to corrosion than steel. However, disadvantages include higher cost and embodied energy, greater thermal expansion, and lower fire resistance than steel.

Most exterior applications using aluminium alloys are anodized surfaces which increase durability, trap dyes, and adhere well to other finishes. Plastic coatings, which are applied electrostatically as a powder and then heat cured, are also used. They give a durable protection layer, with a more uniform appearance. The finished appearance can range from clear to a wide variety of colors and textures, depending on the coating applied. In addition, the panels can be installed with insulation for better thermal performance.

Components:

Aluminium sheet

Steel angles

Ceiling board

Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	886 MJ/m^2

2.23 - Aluminium sheets on Timber Rafters

Description

Besides steel, aluminium is the most commonly used metal in construction. It is one of the lightest and easiest metals to manipulate, bend, shape, cast, fasten, and weld, and is also very ductile, often extruded into shapes for architectural purposes. It can easily be drilled, tapped, sawed, planed, and filed with hand tools, making it a yielding material for tradesmen to use. Aluminium has higher resistance to corrosion than steel. However, disadvantages include higher cost and embodied energy, greater thermal expansion, and lower fire resistance than steel.

Most exterior applications using aluminium alloys are anodized surfaces which increase durability, trap dyes, and adhere well to other finishes. Plastic coatings, which are applied electrostatically as a powder and then heat cured, are also used. They give a durable protection layer, with a more uniform appearance. The finished appearance can range from clear to a wide variety of colors and textures, depending on the coating applied. In addition, the panels can be installed with insulation for better thermal performance.

Components:

- Aluminium sheet
- Timber rafters
- Ceiling board
- Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	812 MJ/m^2

2.24 - Copper Sheets on Steel Rafters

Description

When properly designed and installed, a copper roof provides an economical, long-term roofing solution. Its low life cycle costs are attributable to the low maintenance, long life and salvage value of copper. Unlike many other metal roofing materials, copper requires no painting or finishing.

The original bronze tones naturally weather into a green patina. A number of methods are available to retard or accelerate the weathering process. Copper is ductile and malleable, easy to mould over irregular roof structures. Domes and other curved roof shapes are readily handled with copper. In recent years, new tools and installation methods have been introduced that aid in the quick, proper, and economical installation of copper roofs.

Copper roofing is typically constructed using 0.55 mm or 0.69 mm cold rolled copper sheets. The sheets are usually limited to a width of 600 mm to 900 mm. Sheets can be either preformed or formed in the field into pans. Pans up to 3 metres long are considered short pans. Roofs using pans longer than 3 m should be designed to accommodate additional movement at the ends of the pans. The copper pans rest on rosin-sized smooth building paper. The underlayment is typically saturated roofing felts. Other materials may be substituted in specific applications.

Components:

- Copper Sheet
- Steel angles
- Ceiling board
- Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	879 MJ/m^2

2.25 - Copper Sheets on Timber Rafters

Description

When properly designed and installed, a copper roof provides an economical, long-term roofing solution. Its low life cycle costs are attributable to the low maintenance, long life and salvage value of copper. Unlike many other metal roofing materials, copper requires no painting or finishing.

The original bronze tones naturally weather into a green patina. A number of methods are available to retard or accelerate the weathering process. Copper is ductile and malleable, easy to mould over irregular roof structures. Domes and other curved roof shapes are readily handled with copper. In recent years, new tools and installation methods have been introduced that aid in the quick, proper, and economical installation of copper roofs.

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Components:

Copper Sheet

Timber rafters

Ceiling board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	805 MJ/m^2

2.26 - Asphalt shingles on Steel Rafters

Description

Asphalt shingles are an effective roof covering material for sloped roofs. They can be successfully used on steeper piches as well as moderately "low sloped" roofs (less than 1:3 i.e. 100 mm of vertical rise for every 300 mm of horizontal run, or 18.5°), providing a few special application procedures are followed for low slopes. However, they should not be applied to roof slopes lower than 1:6 (9.5°).

Components:

Asphalt shingles

Steel angles

Ceiling board

Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	245 MJ/m^2

2.27 - Asphalt shingles on Timber Rafters

Description

Asphalt shingles are an effective roof covering material for sloped roofs. They can be successfully used on steeper piches as well as moderately "low sloped" roofs (less than 1:3 i.e. 100 mm of vertical rise for every 300 mm of horizontal run, or 18.5°), providing a few special application procedures are followed for low slopes. However, they should not be applied to roof slopes lower than 1:6 (9.5°).

Components:

Asphalt shingles

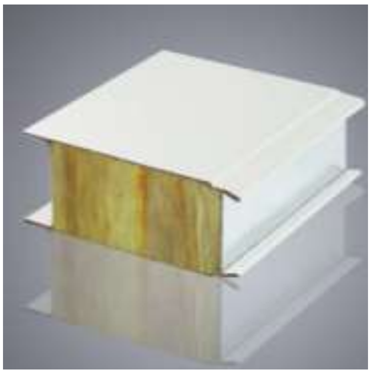
Timber rafters

Ceiling board

Plaster skim coat

Minimum thickness	0.100 m
Default thickness	0.150 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	116 MJ/m^2

2.28 - Aluminum-clad sandwich panel



Description

Sandwich panels provide a combination of high structural rigidity and low weight and are used in a variety of applications. An aluminum-clad sandwich panel is made of three layers: a low-density core with a thin skin-layer of aluminum bonded to each side. The core may be empty or honeycombed and may contain insulation. The values shown here do not include the embodied energy of insulation; any insulation in this assembly must be accounted for separately under Insulation.

Components:

Aluminum profile cladding

Light-weight core

Aluminum profile cladding

Minimum thickness	0.05 m
Default thickness	0.075 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	743 MJ/m^2

2.29 - Steel-clad sandwich panel

Description

Sandwich panels provide a combination of high structural rigidity and low weight and are used in a variety of applications. A steel-clad sandwich panel is made of three layers: a low-density core with a thin skin-layer of steel bonded to each side. The core may be empty or honeycombed and may contain insulation. Steel is stronger than aluminum, so there is less likelihood of the core being honeycombed for strength. The values shown here do not include the embodied energy of insulation; any insulation in this assembly must be accounted for separately under Insulation.

Components:

Steel profile cladding

Light-weight core

Steel profile cladding

Minimum thickness	0.05 m
Default thickness	0.075 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	268 MJ/m^2

2.30 – Re-use of Existing Roof

Description

Re-using an existing material avoids the use of new materials and thus of embodied energy. The re-use of existing materials option in EDGE is highly desirable and assigned an embodied energy value of zero (0). Materials greater than five years old will be considered as embodied-energy neutral, which can be indicated as "re-use of existing materials" within the EDGE App.

Components:	Embodied energy at default thickness
Re-use of existing roof	0 MJ/m^2

M03 – EXTERNAL WALLS

3.01 - Common Brick Wall with internal & external plaster

Description

Common bricks, also known as fired clay bricks, are usually popular with builders as they are easily available and inexpensive. However, because common bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy. In keeping with the ASTM definitions, bricks with void content ranging from 0% to 25% are considered solid bricks in EDGE.

Components:

Plaster finish

Common Brick

Plaster finish

Minimum thickness	0.134 m
Default thickness	0.200 m
Maximum thickness	0.354 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1616 MJ/m^2

3.02 - Cored (with holes) bricks with internal & external plaster

Description

Cored clay blocks, also known as hollow blocks, are made of fired clay and have a cross-section with holes. The holed structure means that there is less material per square meter of finished wall. In keeping with the ASTM definitions, bricks with void content ranging from 25% to 40% are considered cored bricks in EDGE.

Components:

Plaster finish

Cored Brick

Plaster finish

Minimum thickness	0.134 m
Default thickness	0.200 m
Maximum thickness	0.354 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	814 MJ/m^2

3.03 - Honeycomb Clay Blocks with internal & external plaster

Description

Honeycomb clay blocks are made of fired clay and have a honeycombed cross-section resulting in less material per square meter of finished wall. The honeycomb structure makes the blocks strong with high impact resistance, and improves thermal performance. The large size of the blocks enables rapid construction. No mortar is needed in the vertical joints due to tongue and grooved edges, reducing mortar use by up to 40%. The blocks can be customized. Honeycomb clay blocks have post-consumer value if dismantled carefully. In keeping with the ASTM definitions, bricks with void content ranging from 40% to 60% are considered honeycomb blocks in EDGE.

Components:

Plaster finish

Honeycomb brick

Plaster finish

Minimum thickness	0.134 m
Default thickness	0.200 m
Maximum thickness	0.354 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	338 MJ/m^2

3.04 - Medium Weight Hollow Concrete Blocks

Description

Hollow concrete blocks are lightweight and easier to handle than solid concrete blocks. The lightness of the blocks helps in reducing the dead load of the masonry on the structure. The voids also marginally improve the thermal insulation and sound insulation of the block. The larger size of the blocks (compared to conventional burnt clay bricks) also reduces the number of mortar joints and the amount of cement mortar.

Components:

Plaster finish

Hollow medium-density concrete block

Plaster finish

Minimum thickness	0.124 m
Default thickness	0.200 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	234 MJ/m^2

3.05 - Solid Dense Concrete Blocks

Description

Solid dense concrete blocks can be used in virtually any part of a building. They provide excellent sound insulation and their high strength makes them applicable for use in structural walls. However, the use of virgin aggregates and sand can lead to land or marine degradation and resource depletion, and the lack of supplementary materials in the cement results in increased embodied energy.

Components:

Plaster finish

Solid dense concrete block

Plaster finish

Minimum thickness	0.124 m
Default thickness	0.200 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	407 MJ/m^2

3.06 - Autoclaved Aerated Concrete Blocks

Description

Aerated concrete is a versatile, lightweight building material. Compared to solid dense concrete blocks, aerated concrete blocks have lower density and better insulation properties. They are durable and have good resistance to sulfate attack and damage by fire and frost. The manufacture of aerated blocks typically uses 25% less energy than other concrete blocks, when compared based on volume. They are lighter in weight which makes them easier to work with and saves energy in transportation.

Components:

Plaster finish

Aircrete (Autoclaved Aerated Concrete) blocks

Plaster finish

Minimum thickness	0.124 m
Default thickness	0.200 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	317 MJ/m^2

3.07 - Fly-Ash Stabilized Soil Blocks

Description

Fly ash usually refers to industrial waste produced during coal combustion. It is also known as Pulverized Fuel Ash or PFA. Soil blocks stabilized with materials like fly ash or ground granulated blast-furnace slag (GGBS) are much stronger and more stable compared to blocks made with just soil that have some inherent weaknesses.

Components:

Plaster finish

Fly-ash stabilized soil blocks

Plaster finish

Minimum thickness	0.124 m
Default thickness	0.200 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	108 MJ/m^2

3.08 - Compressed Stabilized Earth Blocks

Description

Stabilized Compressed Earth Block (SCEB) technology uses local soil mixed with sand if required and a small percentage (about 5-10%) of ordinary portland cement (OPC) as the stabilizing agent. It offers a cost-effective and environmentally-friendly alternative to conventional building materials. The blocks are fire-resistant, provide better thermal insulation, and do not need to be fired, so they have lower embodied energy.

Components:

Plaster finish

Ordinary portland cement stabilized soil blocks

Plaster finish

Minimum thickness	0.124 m
Default thickness	0.200 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	203 MJ/m^2

3.09 - GGBS Stabilized Soil Blocks

Description

GGBS is a by-product of the iron industry. The molten slag is cooled rapidly with water and is then ground into a fine cementations powder. GGBS then can be used as a cement replacement in stabilized soil blocks.

Components:

Plaster finish

GGBS stabilized soil blocks

Plaster finish

Minimum thickness	0.124 m
Default thickness	0.200 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	94 MJ/m^2

3.10 - Rammed Earth Blocks/Walls

Description

Rammed earth walls are constructed by the compacting (ramming) successive layers of moistened subsoil into place between temporary formwork panels. When dried, the result is a dense, hard monolithic wall. Rammed earth bricks are also available as an alternative. Rammed earth walls are more durable in arid areas. The high moisture mass of rammed earth helps regulate humidity.

Components:

Rammed Earth

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.500 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	43 MJ/m^2

3.11 - Precast Concrete Panels

Description

Precast concrete panels are made by casting concrete in a reusable molding or "form" which is then cured in a controlled environment, transported to the construction site, and lifted into place. They are most commonly used as precast cladding or curtain walls for building envelopes. These types of precast concrete panels do not transfer vertical loads but simply enclose the space. They are only designed to resist wind, seismic forces generated by their own weight, and forces requiring transferring the weight of the panel to the support. Common cladding units include wall panels, window wall units, spandrels, mullions, and column covers. These units can usually be removed individually if necessary. In some cases, precast panels are used as formwork for cast-in-place concrete. The precast panels are left in place providing the visible aesthetics of the system, while the cast-in-place portion provides the structural component.

Components:

Precast concrete panels

Steel reinforcement

Minimum thickness	0.080 m
Default thickness	0.200 m
Maximum thickness	0.150 m
Default reinforcement	20.0 kg / m^2
Embodied energy at default thickness	907 MJ/m^2

3.12 - Straw Bale Blocks

Description

Straw bale blocks are a rapidly renewable building material made from the dry stalk left in the earth after harvest, which is traditionally considered a waste product that is burned or baled and sold for animal use. It is a natural, non-toxic building material with low environmental impact and excellent insulation properties. Since it is very easy to work with, it is a good choice for amateur or unskilled self-builders. Straw bale houses are finished and coated with cement stucco or earth-based plaster, sealing the straw from the elements and giving long-lasting protection with little maintenance. In contrast to the timber used for wood framing, straw can be grown in less than a year in a completely sustainable production system. The conversion of straw into a sustainable renewable resource to be used as a dominant building material could be especially beneficial in areas where the climate is severe and timber is scarce, but straw is plentiful.

Components:

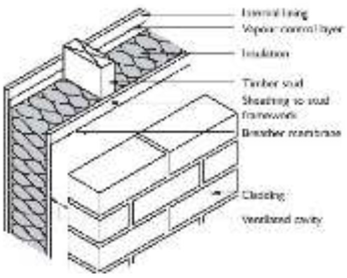
Mud plaster finish

Straw bale blocks

Mud plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.900 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	63 MJ/m^2

3.13 - Facing Brick and Timber Stud



Description

Building walls with timber studs is a light weight construction technique which reduces the dead load of building and increases the pace of construction.

Timber has relatively high embodied energy. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood, which helps to avoid the use of virgin wood for building construction activities.

Components:

- Brick
- Drained air cavity <100mm
- Exterior board
- Timber studs
- Mineral wool insulation (calculated separately)
- Interior plaster board
- Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.450 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1107 MJ/m^2

3.14 - Phosphogypsum Panel

Description

Phosphogypsum is a waste product of the fertilizer industry. The use of phosphogypsum board in buildings is a substitute for natural gypsum. In other respects, the wall is assumed to be similar to an insulated timber stud wall.

Components:	
Plaster finish	
Phosphogypsum panel	
Mineral wool (calculated separately)	
Timber studs	
Phosphogypsum panel	
Plaster finish	

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	218 MJ/m^2

3.15 - Ferrocement Wall Panel

Description

Ferrocement is a very simple construction of 2 to 5 layers of chicken wire over a frame made from reinforcing bar, with ordinary portland cement (OPC) filled into the gaps and in a layer over the chicken wire reinforcing. The use of chicken wire makes ferrocement a very flexible building material that is strongest when curved.

Components:

Ordinary portland cement concrete

Steel mesh and reinforcement

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	20.0 kg / m^2
Embodied energy at default thickness	627 MJ/m^2

3.16 - In-Situ Reinforced Wall

Description

More commonly used for floor slabs and roofs, in-situ reinforced concrete is also used to construct external walls. It has high embodied energy due to the inclusion of ordinary Portland cement (OPC). It also uses sand, aggregate, water, and reinforcing steel.

Components:

Concrete

Steel reinforcement

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	20 kg / m^2
Embodied energy at default thickness	627 MJ/m^2

3.17 - Cellular Light Weight Concrete Blocks

Description

These environmentally friendly blocks are also called CLC blocks. The energy consumed in their production is only a fraction compared to the production of clay bricks. They are made from a slurry of cement, fly ash*, and water, to which pre-formed stable foam is added in an ordinary concrete mixer under ambient conditions. The addition of foam to the concrete mixture creates millions of tiny voids or cells in the material, hence the name Cellular Concrete.

*Fly ash is a waste material produced from burning coal e.g. in thermal power plants.

Components:		
Plaster finish	Minimum thickness	0.200 m
Lightweight concrete block	Default thickness	0.200 m
Plaster finish	Maximum thickness	0.400 m
	Default reinforcement	0.0 kg / m^2
	Embodied energy at default thickness	232 MJ/m^2

3.18 - Stone Blocks

Description

Blocks made of limestone, and machine cut and finished. Limestone is found widely and makes up about 10% of the total volume of all sedimentary rocks. The high embodied energy is because of the energy-intensive extraction process, heavy transportation loads and machined finish. Limestone is relatively easy to cut into blocks in a quarry. It is long-lasting and stands up well to exposure, as it is hard, durable, and commonly occurs in easily accessible exposed surfaces. Because of its mass, limestone also has high thermal inertia. However, it is a very heavy material, making it impractical for tall buildings, and relatively expensive as a building material. Locally extracted stone is preferable because it reduces the amount of fossil fuels used in transportation, and hand cut stone is preferable for its lower embodied energy. For hand-cut stone, see section 3.45.

Components:		
Cut stone for walls	Minimum thickness	0.200 m
	Default thickness	0.200 m
Plaster finish	Maximum thickness	0.400 m
	Default reinforcement	0.0 kg / m^2
	Embodied energy at default thickness	2,282 MJ/m^2

3.19 - FaLG Block

Description

Fly Ash-Lime-Gypsum (FaLG) blocks technology primarily uses industrial wastes such as fly ash (from thermal power plants), lime and gypsum (from fertilizer industries), and sand (optional) to produce alternative materials for walls. It reduces the environmental impacts associated with disposal of these industrial wastes, as well as avoids the environmental impacts associated with clay brick production, such as denudation of fertile topsoil. As the process for FaLG blocks does not require sintering, the amount of energy (fossil fuels) for production is reduced.

Fly ash reacts with lime at ordinary temperatures in the presence of moisture, and forms calcium silicate hydrate (C-S-H) compounds possessing high-strength cementitious properties. The manufacturing process consists of three main stages: (1) Mixing: Fly ash is mixed with lime and gypsum, with the optional addition of a chemical accelerator. (2) Pressing: The mix is molded under pressure in a machine and dried in the air/ sun. And (3) Curing: the green block is water cured.

Generally, FaLG blocks are grey in color, solid, and have plain rectangular faces with parallel sides and sharp straight and right-angled edges. They are also used for development of infrastructure, construction of pavements, dams, tanks, and under water works.

Components:

Plaster finish

FaLG (fly ash/lime/gypsum) block

Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	466 MJ/m^2

3.20 - Steel Profile Cladding

Description

Steel, one of the strongest and most affordable materials, offers a favorable strength-to-weight ratio as well as high elasticity. Other benefits include stiffness and fire and corrosion resistance. Steel wall cladding profiles create economical solutions in both new building and renovation and in operations and maintenance. The profiles are versatile and come in a very broad range of shapes, finishes, and colors that enable innovative designs. In addition, they can be installed with insulation for better thermal performance.

Components:

Corrugated galvanized steel sheets

Steel angles

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	421 MJ/m^2

3.21 - Aluminium Profile Cladding

Description

Beside steel, aluminium is the most commonly used metal in construction. It is one of the lightest and easiest metals to manipulate, bend, shape, cast, fasten, and weld, and is also very ductile, often extruded into shapes for architectural purposes. It can be easily drilled, tapped, sawed, planed, and filed with hand tools, making it a yielding material for tradesmen to use.

Aluminium is commonly used as wall cladding or curtain-walls, as its resistance to corrosion is higher than steel, and it is also lighter than other metals. Most exterior applications using aluminium alloys are anodized surfaces, which increases durability, traps dyes, and adheres to other finishes. Plastic coatings, which are applied electrostatically as a powder and then heat cured, are also used for cladding wall panels. They give a durable protection layer, with a more uniform appearance. The finished appearance can range from clear to a wide variety of colors and textures. In addition, the panels can be installed with insulation for better thermal performance. However, the disadvantages are higher cost and embodied energy, greater thermal expansion, and lower fire resistance as compared to steel.

Components:

Aluminium cladding sheets

Steel angles

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	862 MJ/m^2

3.22 - Exposed Brick Wall with internal plaster

Description

Common bricks, also known as fired clay bricks, are usually popular with builders as they are easily available and inexpensive. However, because common bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy.

Components:

Common Brick

Interior plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1699 MJ/m^2

3.23 - Exposed Cored (with holes) bricks with internal plaster

Description

Cored bricks are made of fired clay and have a holed cross-section. The holed structure means that there is less material per square meter of finished wall.

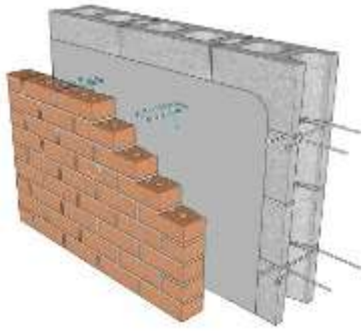
Components:

Cored Brick

Interior plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	843 MJ/m^2

3.24 - Facing Brick and Hollow Concrete Blocks



Description

Facing bricks are bricks made of fired clay and used as the exterior face of a wall. These are generally easily available and inexpensive. However, because clay bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy.

Hollow concrete blocks are used as inner layer of the wall. They are lightweight and easier to handle than solid concrete blocks. The lightness of the blocks helps in reducing the dead load of the masonry on the structure. The voids also marginally improve the thermal insulation and sound insulation of the block. The larger size of the blocks (compared to conventional burnt clay bricks) also reduces the number of mortar joints and the amount of cement mortar.

Components:

Brick Face

Air space <100mm

Hollow medium-density concrete block

Interior plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	980 MJ/m^2

3.25 - Facing Brick and Solid Concrete Blocks

Description

Facing bricks are bricks made of fired clay and used as the exterior face of a wall. These are generally easily available and inexpensive. However, because clay bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy.

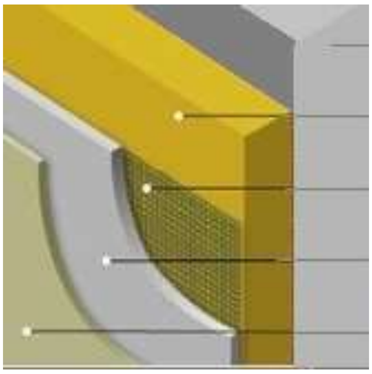
Solid dense concrete blocks form the inner layer of the wall. They can be used in virtually any part of a building. They provide good sound insulation and their high strength makes them applicable for use in structural walls. However, the use of virgin aggregates and sand can lead to land or marine degradation and resource depletion, and the lack of supplementary materials in the cement results in increased embodied energy.

Components:

- Brick Face
- Air space <100mm
- Solid concrete block
- Gypsum plaster

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1042 MJ/m^2

3.26 - Polymeric render on concrete block



Description

The exterior layer is made of polymeric render. Polymer render is a dry premixed polymer and fiber-reinforced powder applied to precast concrete blocks. Requiring only a single coat, polymer render is weather tight when cured, but will freely allow transmission of water vapor. The render is both breathable and flexible. Life expectancy is often in excess of 30 years.

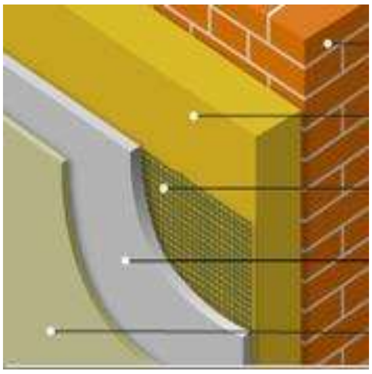
The inside layer is made of concrete blocks. Solid dense concrete blocks can be used in virtually any part of a building. They provide excellent sound insulation and their high strength makes them applicable for use in structural walls. However, the use of virgin aggregates and sand can lead to land or marine degradation and resource depletion, and the lack of supplementary materials in the cement results in increased embodied energy.

Components:

- Cement plaster base coat
- Polyurethane rigid insulation (calculated separately)
- Solid dense concrete blocks
- Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	181 MJ/m^2

3.27 - Polymeric render on Brick



Description

The exterior layer is made of polymeric render. Polymer render is a dry premixed polymer and fiber-reinforced powder applied to precast concrete blocks. Requiring only a single coat, polymer render is weather tight when cured, but will freely allow transmission of water vapor. The render is both breathable and flexible. Life expectancy is often in excess of 30 years.

The inner layer is brick. Common bricks, also known as fired clay bricks, are usually popular with builders as they are easily available and inexpensive. However, because common bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy.

Components:

Cement plaster base coat

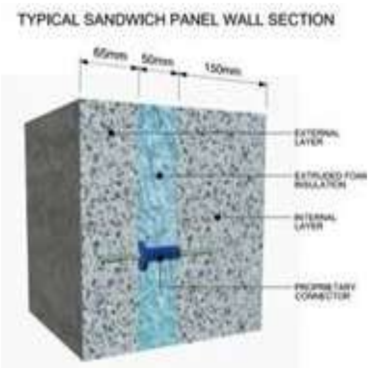
Polyurethane rigid insulation (calculated separately)

Common Brick

Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1,171 MJ/m^2

3.28 - Precast Concrete Sandwich panel



Description

Precast concrete sandwich panels comprise an outer leaf of precast concrete, an insulating layer 'sandwiched' in between, and an inner leaf of plain grey concrete with a power floated finish. The panels may be attached to a steel frame as a *cladding* panel, or they can form part of a precast *structural* frame where the inner leaf is load bearing and the external leaf is connected to and supported off the internal leaf using ties. The ties used in the precast structural frames are made of metal, plastic or epoxy and have low thermal conductivity to eliminate cold bridging. The thickness of the insulation depends on the required U-value. The shape, thickness, and size of the concrete can also be varied to meet the requirements of the project.

Panels are joined to each other using a specialized joint fixing system on the inner leaf which ensures maximum strength and airtightness. The panels slot together, aligning wire loops that protrude from each panel. A steel rod is then fixed through the wire loops and the joint filled with a thixotropic* grout.

Precast concrete sandwich panels offer many advantages. They provide a strong, durable, energy-efficient, and fire-resistant composite cladding system. All aspects of the production process are undertaken in an off-site factory environment, thereby enabling a high quality finish. Construction is much faster with the ability to adopt 'just in time' site delivery and a fully integrated structure and skin system where load-bearing wall panels provide both structural support and external finish, minimising on-site labour cost. Prefabricated sandwich panels also eliminate the need for external scaffolding saving on materials and costs.

* having a viscosity that decreases when a stress is applied, e.g. when stirred

Components:

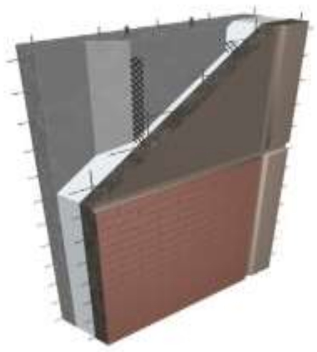
Precast concrete panels – exterior and interior

Steel reinforcement in panels

Polyurethane rigid insulation foam sandwiched in between (calculated separately)

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	15.0 kg / m^2
Embodied energy at default thickness	672 MJ/m^2

3.29 - Brick faced precast concrete sandwich panel



Description

Exterior brick face attached to precast concrete sandwich panels.

The precast concrete sandwich panels comprise an outer leaf of precast concrete, an insulating layer 'sandwiched' in between, and an inner leaf of plain grey concrete with a power floated finish. The panels may be attached to a steel frame as a *cladding* panel, or they can form part of a precast *structural* frame where the inner leaf is load bearing and the external leaf is connected to and supported off the internal leaf using ties. The ties used in the precast structural frames are made of metal, plastic or epoxy and have low thermal conductivity to eliminate cold bridging. The thickness of the insulation depends on the required U-value. The shape, thickness, and size of the concrete can also be varied to meet the requirements of the project.

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* having a viscosity that decreases when a stress is applied, e.g. when stirred

Components:

Brick Facing

Polyurethane rigid insulation foam (calculated separately)

Precast concrete panels

Steel reinforcement

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	5.0 kg / m^2
Embodied energy at default thickness	1,150 MJ/m^2

3.30 - Stone faced precast concrete sandwich panel

Description

Stone face attached to precast concrete sandwich panels.

The precast concrete sandwich panels comprise an outer leaf of precast concrete, an insulating layer 'sandwiched' in between, and an inner leaf of plain grey concrete with a power floated finish. The panels may be attached to a steel frame as a *cladding* panel, or they can form part of a precast *structural* frame where the inner leaf is load bearing and the external leaf is connected to and supported off the internal leaf using ties. The ties used in the precast structural frames are made of metal, plastic or epoxy and have low thermal conductivity to eliminate cold bridging. The thickness of the insulation depends on the required U-value. The shape, thickness, and size of the concrete can also be varied to meet the requirements of the project.

Panels are joined to each other using a specialized joint fixing system on the inner leaf which ensures maximum strength and airtightness. The panels slot together, aligning wire loops that protrude from each panel. A steel rod is then fixed through the wire loops and the joint filled with a thixotropic* grout.

Precast concrete sandwich panels offer many advantages. They provide a strong, durable, energy-efficient, and fire-resistant composite cladding system. All aspects of the production process are undertaken in an off-site factory environment, thereby enabling a high quality finish. Construction is much faster with the ability to adopt 'just in time' site delivery and a fully integrated structure and skin system where load-bearing wall panels provide both structural support and external finish, minimising on-site labour cost. Prefabricated sandwich panels also eliminate the need for external scaffolding saving on materials and costs.

* having a viscosity that decreases when a stress is applied, e.g. when stirred

Components:

Cut stone for walls

Polyurethane rigid insulation foam (calculated separately)

Precast concrete panels

Steel reinforcement

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	11.3 kg / m^2
Embodied energy at default thickness	855 MJ/m^2

3.31 - Glass fiber reinforced concrete cladding

Description

Glass fiber reinforced concrete (GFRC) is an alternative to pre-cast concrete for building façades. Because of its strength, this type of cladding can be produced in thinner sections to meet complex architectural specifications, and is three to five times lighter than standard concrete. GFRC has excellent weather-proof and fire-retardant qualities, and is also more water and pollution-proof than standard concrete. Glass reinforced concrete offers greater versatility due to its superior compressive strength and flexibility. It is also easy to handle and fast to erect and mount on support systems due to its light weight.

Components:

Precast concrete panels

Fibre glass reinforcement

Mineral wool insulation (calculated separately)

Interior wall board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	505 MJ/m^2

3.32 - Stone Profile Cladding

Description

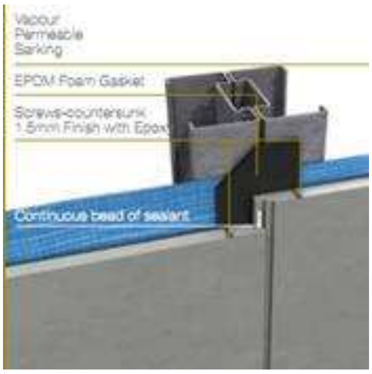
Stone profile cladding is a natural stone panel system consisting of Z-shaped interlocking panels, stone corner pieces (quoins) and integrated fixing clips. All edges on both straight and corner panels are made of hand-dressed stone. The stone cladding panel system uses large (approx.) 600 x 200 mm panels which allows the use of larger pieces of stone to build a panel, giving a natural appearance. It saves both time and money compared to traditional stone masonry.

Components:

- Cut stone for walls
- Hollow steel angles
- Insulation (calculated separately)
- Interior wall board
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	501 MJ/m^2

3.33 - Cement Fibre Boards on Metal Studs



Description

Cement fibre board used to clad buildings may also be referred to as 'siding' or 'ship lap cladding'. It has the advantage of being more stable than wood through an extreme range of weather conditions and it won't rot, twist or warp. It is used to replace timber cladding in new build and refurbishment projects. Boarding is often self-coloured so it doesn't need painting. The board can be fixed in a number of ways to timber or steel studs, and is easily cut by scoring and snapping external corners and edges.

Components:

Cement Fibre Boards

Steel angles

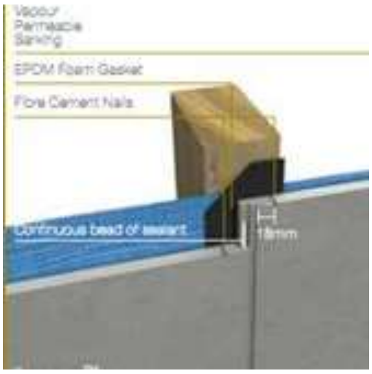
Insulation (calculated separately)

Interior wall board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	241 MJ/m^2

3.34 - Cement Fibre Boards on Timber Studs



Description

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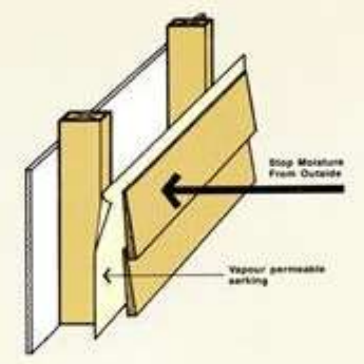
Timber has relatively high embodied energy. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood, which helps to avoid the use of virgin wood for building construction activities.

Components:

- Cement Fibre Boards
- Timber studs
- Insulation (calculated separately)
- Interior wall board
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	67 MJ/m^2

3.35 - Timber Weatherboard on Timber Studs



Description

Timber cladding can be used in many forms to achieve a wide variety of pattern, texture and colour ranging from the use of shingles or shakes through to prefinished panels. However, the most common form of timber cladding consists of boards laid vertically, diagonally or horizontally with either overlapping or flush faces. Where cladding battens are installed over a timber frame structure, they are normally fixed into the solid timber studs through the breather membrane and sheathing board at maximum 600mm centres. Where cladding battens are installed over a masonry structure, they are normally fixed at maximum 600mm centres using suitable plug and screw type fasteners. A damp proof course (DPC) may be specified between the timber batten and the structure behind to reduce the risk of moisture transfer from the masonry to timber batten. This risk will vary depending on board profile and exposure. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood.

Components:
Timber weatherboard
Timber studs
Insulation (calculated separately)
Interior wall board
Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	89 MJ/m^2

3.36 - UPVC Weatherboard on timber studs

Description

UPVC (unplasticised polyvinyl chloride) is a tough, durable plastic. UPVC cladding looks similar to timber cladding but usually has a thinner section as UPVC can be easily moulded; It can be easier to work with UPVC than timber because it is manufactured with more accurate dimensions, does not twist, warp or split and there are no knots in it. UPVC is available in different colours, although white seems to be the the most widely used; where a colour other than white is required, most manufacturers just apply a thin coating of colour over white UPVC. UPVC is considered to be low maintenance. However, in the case of painted UPVC, any scrapes and damage to the surface may reveal the white underneath. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood.

Components:	
UPVC planks	
Timber studs	
Insulation (calculated separately)	
Interior wall board	
Plaster finish	

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	117 MJ/m^2

3.37 - Clay tiles cladding (or 'Terracotta rainscreen cladding') on metal studs

Description

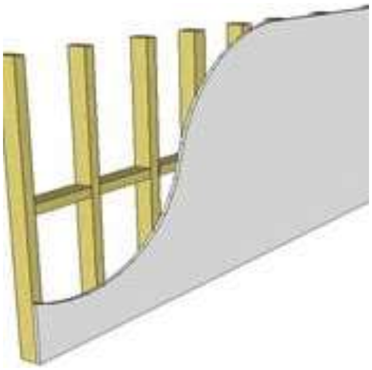
Terracotta rainscreen tiles are fixed onto a steel or aluminium substructure. The substructure is generally formed of vertical 'T' support rails and adjustable brackets, or brackets fixed along the horizontal axis of the support wall. Terracotta tiles are then mounted on the substructure using self-tapping stainless steel screws or aluminium hollow rivets, and held in place at four points with proprietary clips. Terracotta tiles are made of clay fired at high temperatures, normally achieved by the combustion of fossil fuels, and therefore have high embodied energy.

Components:

- Terracotta tiles
- Steel channels
- Insulation (calculated separately)
- Interior wall board
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	435 MJ/m^2

3.38 - Plasterboards on timber studs



Description

Plasterboard is a form of wallboard manufactured using a core of gypsum plaster bonded to layers of paper or fiberboard. It can be mounted on timber studs. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood, which helps to avoid the use of virgin wood for building construction activities.

Components:

- Plaster finish
- Exterior wall plaster board
- Timber studs
- Insulation (calculated separately)
- Interior wall board
- Plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	102 MJ/m^2

3.39 - Plasterboards on metal studs

Description

Plasterboard is a form of wallboard manufactured using a core of gypsum plaster bonded to layers of paper or fiberboard. The plaster board may be mounted on studwork made from galvanised steel sheet profiles.

Components:

- Exterior plaster finish
- Exterior wall plasterboard
- Steel channels
- Insulation (calculated separately)
- Interior wall board
- Interior plaster finish

Minimum thickness	0.100 m
Default thickness	0.200 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	259 MJ/m^2

3.40 - Curtain walling (opaque element)

Description

A curtain wall is a vertical building enclosure which supports no load other than its own weight and the environmental forces which act upon it. Curtain walls are not intended to assist in maintaining the structural integrity of a building. Dead loads and live loads are thus not intended to be transferred via the curtain wall to the foundations.

Curtain walling systems come in two basic types: (1) 'Proprietary' curtain walling, which uses a manufacturer's standardised components, and (2) 'Bespoke' or 'Custom' systems, which are purpose-designed for each particular project. Aluminium framing is used for the vast majority of curtain walling applications, primarily for its excellent strength-to-weight ratio and its ability to be extruded into complex shapes.

Components:

Alumunium cladding panels

Air gap

Insulation (calculated separately)

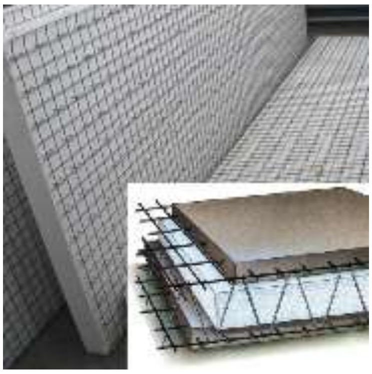
Interior wall board

Interior plaster finish

Aluminium extrusion profile (window frame)

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	1,204 MJ/m^2

3.41 - 3-D Wire panel with 'shot-crete' both sides



Description

3D wire panel is a spatial structure consisting of the following elements:

- Welded reinforcing mesh of high wire diameter 3mm and a mesh size 50 × 50mm
- Diagonal wire (stainless or galvanized) wire of diameter 4mm
- Core of expanded polystyrene of thickness 50 - 120mm
- Concrete sprayed on the wire structure

Components:

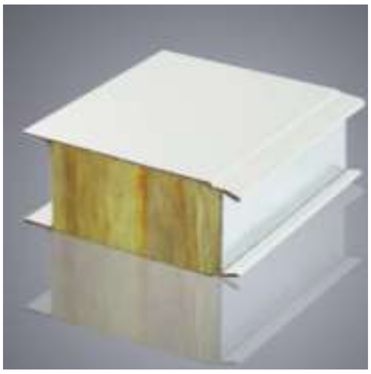
Shot-crete interior and exterior

Steel mesh and reinforcement

Expanded polystyrene insulation (EPS) (insulation calculated separately)

Minimum thickness	0.150 m
Default thickness	0.200 m
Maximum thickness	0.270 m
Default reinforcement	8 kg / m^2
Embodied energy at default thickness	281 MJ/m^2

3.42 - Aluminum-clad sandwich panel



Description

Sandwich panels provide a combination of high structural rigidity and low weight and are used in a variety of applications. An aluminum-clad sandwich panel is made of three layers: a low-density core with a thin skin-layer of aluminum bonded to each side. The core may be empty or honeycombed and may contain insulation. The values shown here do not include the embodied energy of insulation; any insulation in this assembly must be accounted for separately under Insulation.

Components:

Aluminum profile cladding

Light-weight core

Aluminum profile cladding

Minimum thickness	0.05 m
Default thickness	0.10 m
Maximum thickness	0.20 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	743 MJ/m^2

3.43 - Steel-clad sandwich panel

Description

Sandwich panels provide a combination of high structural rigidity and low weight and are used in a variety of applications. A steel-clad sandwich panel is made of three layers: a low-density core with a thin skin-layer of steel bonded to each side. The core may be empty or honeycombed and may contain insulation. Steel is stronger than aluminum, so there is less likelihood of the core being honeycombed for strength. The values shown here do not include the embodied energy of insulation; any insulation in this assembly must be accounted for separately under Insulation.

Components:

Steel profile cladding

Light-weight core

Steel profile cladding

Minimum thickness	0.05 m
Default thickness	0.10 m
Maximum thickness	0.20 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	268 MJ/m^2

3.44 – Re-use of Existing Wall

Description

Re-using an existing material avoids the use of new materials and thus of embodied energy. The re-use of existing materials option in EDGE is highly desirable and assigned an embodied energy value of zero (0). Materials greater than five years old will be considered as embodied-energy neutral, which can be indicated as "re-use of existing materials" within the EDGE App.

Components:	Embodied energy at default thickness
Re-use of existing wall	0 MJ/m^2

3.45 - Stone Blocks – Hand Cut

Description

Hand cut blocks made of limestone. Limestone is found widely and makes up about 10% of the total volume of all sedimentary rocks. The embodied energy is in the extraction process and heavy transportation loads. Locally extracted stone is preferable because it reduces the amount of fossil fuels used in transportation. Limestone is relatively easy to cut into blocks in a quarry. It is long-lasting and stands up well to exposure, as it is hard, durable, and commonly occurs in easily accessible exposed surfaces. Because of its mass, limestone also has high thermal inertia. However, it is a very heavy material, making it impractical for tall buildings, and relatively expensive as a building material.

Components:

Plaster finish

Cut stone for walls

Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	239 MJ/m^2

3.46 - Stone Blocks – Machine Cut and Unpolished

Description

Machine cut blocks made of quarry stone. The embodied energy is in the extraction process and the mechanized saw cutting. Locally extracted stone is preferable because it reduces the amount of fossil fuels used in transportation. Quarry stone is not as easy to cut as limestone. It is long-lasting and stands up well to exposure, as it is hard, durable, and commonly occurs in easily accessible exposed surfaces in certain parts of the globe. Because of its mass, it also has high thermal inertia. However, it is a very heavy material, making it impractical for tall buildings, and relatively expensive as a building material.

Components:

Cut stone for walls

Interior Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	450 MJ/m^2

M04 – INTERNAL WALLS

4.01 - Common Brick Wall with plaster both side

Description

Common bricks, also known as fired clay bricks, are usually popular with builders as they are easily available and inexpensive. However, because common bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy. In keeping with the ASTM definitions, bricks with void content ranging from 0% to 25% are considered solid bricks in EDGE.

Components:

Plaster finish

Common Brick

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.354 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	725 MJ/m^2

4.02 - Cored (with holes) bricks with plaster both side

Description

Cored clay blocks are made of fired clay and have a holed cross-section. The holed structure means that there is less material per square meter of finished wall. In keeping with the ASTM definitions, bricks with void content ranging from 25% to 40% are considered cored bricks in EDGE.

Components:

Plaster finish

Cored Brick

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.354 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	379 MJ/m^2

4.03 - Honeycomb Clay Blocks with plaster both side

Description

Honeycomb clay blocks are made of fired clay and have a honeycombed cross-section resulting in less material per square meter of finished wall. The honeycomb structure makes the blocks strong with high impact resistance, and improves thermal performance. The large size of the blocks enables rapid construction. No mortar is needed in the vertical joints due to tongue and grooved edges, reducing mortar use by up to 40%. The blocks can be customized. Honeycomb clay blocks have post-consumer value if dismantled carefully. In keeping with the ASTM definitions, bricks with void content ranging from 40% to 60% are considered honeycomb blocks in EDGE.

Components:

Plaster finish

Honeycomb brick

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.354 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	173 MJ/m^2

4.04 - Medium Weight Hollow Concrete Blocks

Description

Hollow concrete blocks are lighter in weight and easier to handle than solid concrete blocks. The lightness of the blocks helps in reducing the dead load of the masonry on the structure. The voids also marginally improve the thermal insulation and sound insulation of the block. The larger size of the blocks (compared to conventional burnt clay bricks) also reduces the number of mortar joints and the amount of cement mortar.

Components:

Plaster finish

Hollow medium-density concrete block

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	128 MJ/m^2

4.05 - Solid Dense Concrete Blocks

Description

Solid dense concrete blocks can be used in virtually any part of a building. They provide excellent sound insulation and their high strength makes them applicable for use in structural walls. However, the use of virgin aggregates and sand can lead to land or marine degradation and resource depletion, and the lack of supplementary materials in the cement results in increased embodied energy.

Components:

Plaster finish

Solid dense concrete block

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	203 MJ/m^2

4.06 - Autoclaved Aerated Concrete Blocks

Description

Aerated concrete is a versatile, lightweight building material. Compared to solid dense concrete blocks, aerated concrete blocks have lower density and better insulation properties. They are durable and have good resistance to sulfate attack and damage by fire and frost. The manufacture of aerated blocks typically uses 25% less energy than other concrete blocks, when compared based on volume. They are lighter in weight which makes them easier to work with and saves energy in transportation.

Components:

Plaster finish

Aircrete (Autoclaved Aerated Concrete) blocks

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	174 MJ/m^2

4.07 - Fly-Ash Stabilized Soil Blocks

Description

Fly ash usually refers to industrial waste produced during coal combustion. It is also known as Pulverized Fuel Ash or PFA. Soil blocks stabilized with materials like fly ash or ground granulated blast-furnace slag (GGBS) are much stronger and more stable compared to blocks made with just soil that have some inherent weaknesses.

Components:

Plaster finish

Fly-ash stabilized soil blocks

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	84 MJ/m^2

4.08 - Compressed Stabilized Earth Blocks

Description

Stabilized Compressed Earth Block (SCEB) technology uses local soil mixed with sand if required and a small percentage (about 5-10%) of ordinary portland cement (OPC) as the stabilizing agent. It offers a cost-effective and environmentally-friendly alternative to conventional building materials. The blocks are fire-resistant, provide better thermal insulation, and do not need to be fired, so they have lower embodied energy.

Components:

Plaster finish

Ordinary portland cement stabilized soil blocks

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	125 MJ/m^2

4.09 - GGBS Stabilized Soil Blocks

Description

GGBFS is a by-product of the iron industry. The molten slag is cooled rapidly with water and is then ground into a fine cementations powder. GGBFS then can be used as a cement replacement in stabilized soil blocks.

Components:

Plaster finish

GGBS stabilized soil blocks

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.324 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	78 MJ/m^2

4.10 - Rammed Earth Blocks/Walls

Description

Rammed earth walls are constructed by the compacting (ramming) successive layers of moistened subsoil into place between temporary formwork panels. When dried, the result is a dense, hard monolithic wall. Rammed earth bricks are also available as an alternative. Rammed earth walls are more durable in arid areas. The high moisture mass of rammed earth helps regulate humidity.

Components:

Rammed Earth

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.500 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	58 MJ/m^2

4.11 - Precast Concrete Panels

Description

Precast concrete panels are made by casting concrete in a reusable molding or "form" which is then cured in a controlled environment, transported to the construction site, and lifted into place. They are most commonly used as precast cladding or curtain walls for building envelopes. These types of precast concrete panels do not transfer vertical loads but simply enclose the space. They are only designed to resist wind, seismic forces generated by their own weight, and forces requiring transferring the weight of the panel to the support. Common cladding units include wall panels, window wall units, spandrels, mullions, and column covers. These units can usually be removed individually if necessary. In some cases, precast panels are used as formwork for cast-in-place concrete. The precast panels are left in place providing the visible aesthetics of the system, while the cast-in-place portion provides the structural component.

Components:

Precast concrete panels

Steel reinforcement

Minimum thickness	0.080 m
Default thickness	0.100 m
Maximum thickness	0.150 m
Default reinforcement	18.0 kg / m^2
Embodied energy at default thickness	518 MJ/m^2

4.12 - Straw Bale Blocks

Description

Straw bale blocks are a rapidly renewable building material made from the dry stalk left in the earth after harvest, which is traditionally considered a waste product that is burned or baled and sold for animal use. It is a natural, non-toxic building material with low environmental impact and excellent insulation properties. Since it is very easy to work with it is a good choice for amateur or unskilled self-builders.

Straw bale houses are finished and coated with cement stucco or earth-based plaster, sealing the straw from the elements and giving long-lasting protection with little maintenance. In contrast to the timber used for wood framing, straw can be grown in less than a year in a completely sustainable production system. The conversion of straw into a sustainable renewable resource to be used as a dominant building material could be especially beneficial in areas where the climate is severe and timber is scarce, but straw is plentiful.

Components:		
Mud plaster finish	Minimum thickness	0.100 m
Straw bale blocks	Default thickness	0.100 m
Mud plaster finish	Maximum thickness	0.900 m
	Default reinforcement	0.0 kg / m^2
	Embodied energy at default thickness	88 MJ/m^2

4.13 - Ferrocement Wall Panel

Description

Ferrocement is a very simple construction of 2 to 5 layers of chicken wire over a frame made from reinforcing bar, with ordinary portland cement (OPC) forced into the gaps and in a layer over the chicken wire reinforcing. The use of chicken wire makes ferrocement a very flexible building material that is strongest when curved.

Components:

Ordinary portland cement concrete

Steel mesh and reinforcement

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	5.1 kg / m^2
Embodied energy at default thickness	369 MJ/m^2

4.14 - In-Situ Reinforced Wall

Description

More commonly used for floor slabs and roofs, in-situ reinforced concrete is also used to construct external walls. It has high embodied energy because it uses ordinary Portland cement (OPC). It also uses sand, aggregate, water, and reinforcing steel.

Components:

Concrete

Steel reinforcement

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	10.0 kg / m^2
Embodied energy at default thickness	369 MJ/m^2

4.15 - Cellular Light Weight Concrete Blocks

Description

These environmentally friendly blocks are also called CLC blocks. The energy consumed in their production is only a fraction compared to the production of clay bricks. They are made from a slurry of cement, fly ash*, and water, to which pre-formed stable foam is added in an ordinary concrete mixer under ambient conditions. The addition of foam to the concrete mixture creates millions of tiny voids or cells in the material, hence the name Cellular Concrete.

*Fly ash is a waste material produced from burning coal e.g. in thermal power plants.

Components:

Plaster finish

Lightweight concrete block

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	128 MJ/m^2

4.16 - Stone Blocks

Description

Blocks made of limestone, and machine cut and finished. Limestone is found widely and makes up about 10% of the total volume of all sedimentary rocks. The high embodied energy is because of the energy-intensive extraction process, heavy transportation loads and machined finish. Limestone is relatively easy to cut into blocks in a quarry. It is long-lasting and stands up well to exposure, as it is hard, durable, and commonly occurs in easily accessible exposed surfaces. Because of its mass, limestone also has high thermal inertia. However, it is a very heavy material, making it impractical for tall buildings, and relatively expensive as a building material. Locally extracted stone is preferable because it reduces the amount of fossil fuels used in transportation, and hand cut stone is preferable for its lower embodied energy. For hand-cut stone, see section 4.30.

Components:

Plaster finish

Cut stone for walls

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	1,249 MJ/m^2

4.17 - FaLG Block

Description

Fly Ash-Lime-Gypsum (FaLG) blocks technology primarily uses industrial wastes such as fly ash (from thermal power plants), lime and gypsum (from fertilizer industries), and sand (optional) to produce alternative materials for walls. It reduces the environmental impacts associated with disposal of these industrial wastes, as well as avoids the environmental impacts associated with clay brick production, such as denudation of fertile topsoil. As the process for FaLG blocks does not require sintering, the amount of energy (fossil fuels) for production is reduced.

Fly ash reacts with lime at ordinary temperatures in the presence of moisture, and forms calcium silicate hydrate (C-S-H) compounds possessing high-strength cementitious properties. The manufacturing process consists of three main stages: (1) Mixing: Fly ash is mixed with lime and gypsum, with the optional addition of a chemical accelerator. (2) Pressing: The mix is molded under pressure in a machine and dried in the air/ sun. And (3) Curing: the green block is water cured.

Generally, FaLG blocks are grey in color, solid, and have plain rectangular faces with parallel sides and sharp straight and right-angled edges. They are also used for development of infrastructure, construction of pavements, dams, tanks, and under water works.

Components:

Plaster finish

FaLG (fly ash/lime/gypsum) block

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	228 MJ/m^2

4.18 - Common Brick Wall no finish

Description

Common bricks, also known as fired clay bricks, are usually popular with builders as they are easily available and inexpensive. However, because common bricks are fired at high temperatures, normally achieved by the combustion of fossil fuels, they have high embodied energy.

Components:

Common Brick

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	891 MJ/m^2

4.19 - Cored (with holes) bricks no finish

Description

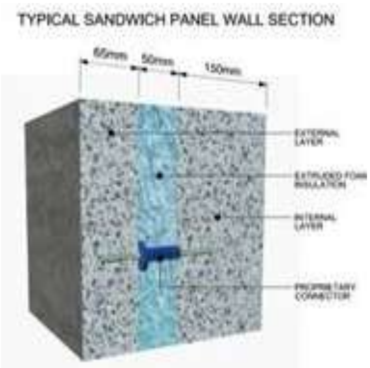
Cored clay blocks are made of fired clay and have a holed cross-section. The holed structure means that there is less material per square meter of finished wall.

Components:

Cored Brick

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	436 MJ/m^2

4.20 - Precast Concrete Sandwich panel



Description

Precast concrete sandwich panels comprise an outer leaf of precast concrete, an insulating layer 'sandwiched' in between, and an inner leaf of plain grey concrete with a power floated finish. The panels may be attached to a steel frame as a *cladding* panel, or they can form part of a precast *structural* frame where the inner leaf is load bearing and the external leaf is connected to and supported off the internal leaf using ties. The ties used in the precast structural frames are made of metal, plastic or epoxy and have low thermal conductivity to eliminate cold bridging. The thickness of the insulation depends on the required U-value. The shape, thickness, and size of the concrete can also be varied to meet the requirements of the project.

Panels are joined to each other using a specialized joint fixing system on the inner leaf which ensures maximum strength and airtightness. The panels slot together, aligning wire loops that protrude from each panel. A steel rod is then fixed through the wire loops and the joint filled with a thixotropic* grout.

Precast concrete sandwich panels offer many advantages. They provide a strong, durable, energy-efficient, and fire-resistant composite cladding system. All aspects of the production process are undertaken in an off-site factory environment, thereby enabling a high quality finish. Construction is much faster with the ability to adopt 'just in time' site delivery and a fully integrated structure and skin system where load-bearing wall panels provide both structural support and external finish, minimising on-site labour cost. Prefabricated sandwich panels also eliminate the need for external scaffolding saving on materials and costs.

* having a viscosity that decreases when a stress is applied, e.g. when stirred

Components:

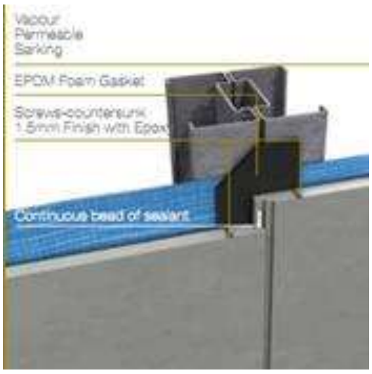
Precast concrete panels both sides

Steel reinforcement in panels

Polyurethane rigid insulation foam sandwiched in between (accounted for elsewhere)

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.400 m
Default reinforcement	27.0 kg / m^2
Embodied energy at default thickness	283 MJ/m^2

4.21 - Cement Fibre Boards on Metal Studs



Description

Cement fibre board used to clad buildings may also be referred to as 'siding' or 'ship lap cladding'. It has the advantage of being more stable than wood through an extreme range of weather conditions and it won't rot, twist or warp. It is used to replace timber cladding in new build and refurbishment projects. Boarding is often self-coloured so it doesn't need painting. The board can be fixed in a number of ways to timber or steel studs, and is easily cut by scoring and snapping external corners and edges.

Components:

Cement Fibre Boards

Steel angles

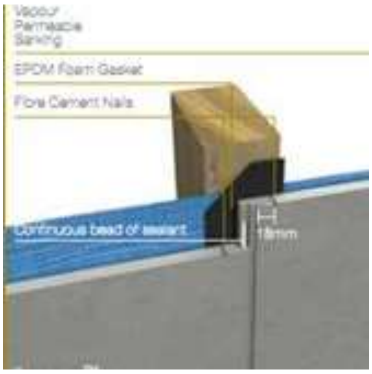
Insulation (accounted for elsewhere)

Interior wall board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	265 MJ/m^2

4.22 - Cement Fibre Boards on Timber Studs



Description

Cement fibre board used to clad buildings may also be referred to as 'siding' or 'ship lap cladding'. It has the advantage of being more stable than wood through an extreme range of weather conditions and it won't rot, twist or warp. It is used to replace timber cladding in new build and refurbishment projects. Boarding is often self-coloured so it doesn't need painting. The board can be fixed in a number of ways to timber or steel studs, and is easily cut by scoring and snapping external corners and edges. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood.

Components:

Timber weatherboard

Timber studs

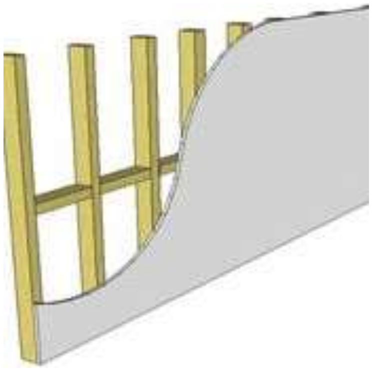
Insulation (accounted for elsewhere)

Interior wall board

Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	91 MJ/m^2

4.23 - Plasterboards on timber studs



Description

Plasterboard is a form of wallboard manufactured using a core of gypsum plaster bonded to layers of paper or fiberboard. It can be mounted on timber studs. Timber has relatively high embodied energy value. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood, which helps to avoid the use of virgin wood for building construction activities.

Components:
Plaster finish
Exterior wall plaster board
Timber studs
Insulation (accounted for elsewhere)
Interior wall board
Plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	150 MJ/m^2

4.24 - Plasterboards on timber studs with insulation

Description

Plasterboard is a form of wallboard manufactured using a core of gypsum bonded to layers of paper or fiberboard. It can be mounted on timber studs. Timber for stud walls should be made from local forest-department-certified wood or a forest-stewardship-council-certified wood, which helps to avoid the use of virgin wood for building construction activities.

The embodied energy of the insulation is included in the values shown in the table.

Components:		
Exterior plaster finish	Minimum thickness	0.100 m
Exterior wall plasterboard	Default thickness	0.100 m
Timber studs	Maximum thickness	0.200 m
Mineral wool insulation	Default reinforcement	0.0 kg / m^2
Interior wall board	Embodied energy at default thickness	175 MJ/m^2
Plaster finish		

4.25 - Plasterboards on metal studs

Description

Plasterboard is a form of wallboard manufactured using a core of gypsum plaster bonded to layers of paper or fiberboard. The plasterboard may be mounted on studwork made from galvanised steel sheet profiles.

Components:

Exterior plaster finish

Exterior wall plasterboard

Steel channels

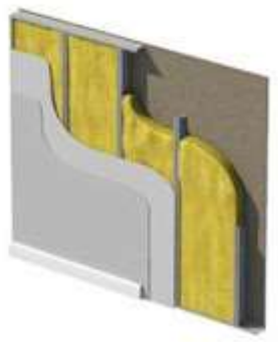
Insulation (accounted for elsewhere)

Interior wall board

Interior plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	324 MJ/m^2

4.26 - Plasterboards on metal studs with insulation



Description

Plasterboard is a form of wallboard manufactured using a core of gypsum plaster bonded to layers of paper or fiberboard. The board may be mounted on studwork made from galvanised steel sheet profiles. Mineral wool insulation is added betwene the studs.

The embodied energy of the insulation is included in the values shown in the table.

Components:

- Exterior plaster finish
- Exterior wall plasterboard
- Steel channels
- Mineral wool insulation (included)
- Interior wall board
- Interior plaster finish

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.200 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	353 MJ/m^2

4.27 - 3-D Wire panel with 'shot-crete' both sides

Description

3D wire panel is a spatial structure consisting of the following elements:

- Welded reinforcing mesh of high wire diameter 3mm and a mesh size 50 × 50mm.
- Core of expanded polystyrene of thickness 50 - 120mm.
- Diagonal wire (stainless or galvanized) wire of diameter 4mm.

Embodied energy of insulation is not included in the values shown below.

Components:		
Shot-crete interior and exterior	Minimum thickness	0.100 m
Steel mesh and reinforcement	Default thickness	0.100 m
Expanded polystyrene insulation (EPS) (accounted for elsewhere)	Maximum thickness	0.270 m
	Default reinforcement	8 kg / m^2
	Embodied energy at default thickness	305 MJ/m^2

4.28 - 3-D Wire panel with 'shot-crete' both sides -- with insulation

Description

3D wire panel is a spatial structure consisting of the following elements:

- Welded reinforcing mesh of high wire diameter 3mm and a mesh size 50 × 50mm.
- Core of expanded polystyrene of thickness 50 - 120mm.
- Diagonal wire (stainless or galvanized) wire of diameter 4mm.

Embodied energy of insulation is included in the values shown below.

Components:

Shot-crete interior and exterior

Steel mesh and reinforcement

Expanded polystyrene insulation (EPS)

Minimum thickness	0.100 m
Default thickness	0.100 m
Maximum thickness	0.270 m
Default reinforcement	8 kg / m^2
Embodied energy at default thickness	387 MJ/m^2

4.29 – Re-use of Existing Wall

Description

Re-using an existing material avoids the use of new materials and thus of embodied energy. The re-use of existing materials option in EDGE is highly desirable and assigned an embodied energy value of zero (0). Materials greater than five years old will be considered as embodied-energy neutral, which can be indicated as "re-use of existing materials" within the EDGE App.

Components:	Embodied energy at default thickness	
Re-use of existing wall		0 MJ/m^2

4.30 - Stone Blocks – Hand Cut

Description

Hand cut blocks made of limestone. Limestone is found widely and makes up about 10% of the total volume of all sedimentary rocks. The embodied energy is in the extraction process and heavy transportation loads. Locally extracted stone is preferable because it reduces the amount of fossil fuels used in transportation. Limestone is relatively easy to cut into blocks in a quarry. It is long-lasting and stands up well to exposure, as it is hard, durable, and commonly occurs in easily accessible exposed surfaces. Because of its mass, limestone also has high thermal inertia. However, it is a very heavy material, making it impractical for tall buildings, and relatively expensive as a building material.

Components:		
Plaster finish	Minimum thickness	0.100 m
Cut stone for walls	Default thickness	0.100 m
Plaster finish	Maximum thickness	0.400 m
	Default reinforcement	0.0 kg / m^2
	Embodied energy at default thickness	162 MJ/m^2

4.31 - Stone Blocks – Machine Cut and Unpolished

Description

Machine cut blocks made of quarry stone. The embodied energy is in the extraction process and the mechanized saw cutting. Locally extracted stone is preferable because it reduces the amount of fossil fuels used in transportation. Quarry stone is not as easy to cut as limestone. It is long-lasting and stands up well to exposure, as it is hard, durable, and commonly occurs in easily accessible exposed surfaces in certain parts of the globe. Because of its mass, it also has high thermal inertia. However, it is a very heavy material, making it impractical for tall buildings, and relatively expensive as a building material.

Components:

Plaster finish

Cut stone for walls

Plaster finish

Minimum thickness	0.200 m
Default thickness	0.200 m
Maximum thickness	0.400 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	450 MJ/m^2

M05 – FLOORING

The embodied energy of flooring materials includes the base layers applied over the floor slab such as adhesive and cement floor screed. Some of these base layers such as adhesive, can significantly increase the embodied energy values of seemingly benign materials such as jute flooring.

5.01 - Ceramic Tile

Description

Ceramic tiles are hard wearing, which minimizes the maintenance required. However, the grout between the tiles does require maintenance. Ceramic tiles have high embodied energy because of the large amounts of energy required for firing to harden them during the manufacturing process.

Components:		
Ceramic tiles	Minimum thickness	0.005 m
Cement mortar	Default thickness	0.010 m
Cement floor screed	Maximum thickness	0.015 m
	Default reinforcement	0 kg / m^2
	Embodied energy at default thickness	199 MJ/m^2

5.02 - Vinyl Flooring

Description

Vinyl flooring is water resistant, low maintenance, and inexpensive. It is easy to install and is durable. However, vinyl flooring has high embodied energy and can release harmful volatile organic compounds after installation. Although durable, vinyl flooring must be laid on a flat, smooth surface. An uneven surface might cause wearing and holes which are difficult to repair, as vinyl is usually laid as a single sheet. Vinyl tiles are also available.

Components:

Vinyl (PVC) flooring

Adhesive for flooring

Cement floor screed

Minimum thickness	0.002 m
Default thickness	0.002 m
Maximum thickness	0.004 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	164 MJ/m^2

5.03 - Stone Tiles/Slabs

Description

Stone tiles despite being natural materials have relatively high embodied energy.

Components:	Minimum thickness	0.010 m
Stone floor tiles	Default thickness	0.020 m
Cement mortar	Maximum thickness	0.025 m
Cement floor screed	Default reinforcement	0 kg / m^2
	Embodied energy at default thickness	264 MJ/m^2

5.04 - Finished Concrete Floor

Description

More commonly referred to as "screed," cement plaster is often used as a preparation layer for soft or flexible floor finishes or tiles. Cement plaster can also be used as a finish layer, but it chips more easily than other hard flooring options.

Components:

Cement floor screed

Minimum thickness	0.015 m
Default thickness	0.035 m
Maximum thickness	0.050 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	70 MJ/m^2

5.05 - Linoleum Sheet

Description

Linoleum, often referred to as lino, is a floor covering made from solidified linseed oil (linoxyn), pine rosin, ground cork dust, wood flour, and mineral fillers such as calcium carbonate. These materials are added to a canvas backing; pigments are often added to the materials. Linoleum appears similar to vinyl and can be used as an alternative and has much lower embodied energy.

Components:

Linoleum

Adhesive for flooring

Cement floor screed

Minimum thickness	0.002 m
Default thickness	0.002 m
Maximum thickness	0.005 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	143 MJ/m^2

5.06 - Terrazzo Tiles

Description

Terrazzo tiles are a hard-wearing option for flooring, requiring very little maintenance. Terrazzo floors can be laid in situ by pouring concrete or resin with granite chips and then polishing the surface. Alternatively, terrazzo tiles can be manufactured in a factory before being laid onsite.

Components:

Cement-based Terrazzo

Cement mortar

Cement floor screed

Minimum thickness	0.015 m
Default thickness	0.020 m
Maximum thickness	0.025 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	99 MJ/m^2

5.07 - Nylon Carpets

Description

Most nylon carpets have high embodied energy because of the large amount of energy used in their manufacture and also due to the fact that nylon is made from oil. Nylon carpets have good acoustic properties and help to reduce reverberation times as well as the transfer of impact sound.

Components:

Nylon Carpet

Carpet underlayment

Cement floor screed

Minimum thickness	0.003 m
Default thickness	0.003 m
Maximum thickness	0.015 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	235 MJ/m^2

5.08 - Laminated Wooden Flooring

Description

Laminated wooden flooring is more dimensionally stable than solid wood flooring so it can be used in rooms prone to changes in moisture levels or where underfloor heating is used, and the initial capital cost is lower than solid wood. But the number of times that it can be refinished is less compared to solid wood flooring because of the relatively small thickness of the finish layer.

Components:

Laminated wooden flooring

Carpet underlayment

Cement floor screed

Minimum thickness	0.010 m
Default thickness	0.010 m
Maximum thickness	0.025 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	277 MJ/m^2

5.09 - Terracotta Tiles

Description

Terracotta is fine-grained, orange, or reddish-brown fired clay that is used for several construction and decorative purposes, mainly in roof and floor tiles. The name comes from Italian, which means "baked earth", as it is literally baked or fired earth or soil.

The color varies slightly depending on the clay used. Terra cotta can be made waterproof by burnishing and glazing and is a sturdy material. Its durability and resistance to both fire and water make it an ideal building material. It is also lighter than stone, and can be glazed to provide a wide variety of colors including finishes that resemble stone or metal patina. Terracotta is a relatively inexpensive material.

Components:		
Terracotta tiles	Minimum thickness	0.012 m
Cement mortar	Default thickness	0.020 m
Cement floor screed	Maximum thickness	0.025 m
	Default reinforcement	0 kg / m^2
	Embodied energy at default thickness	250 MJ/m^2

5.10 - Parquet / Wood Block Finishes

Description

Parquet is wood block flooring in a geometric pattern. It is available in either solid or engineered construction, both of which can be manufactured to have an aged, rustic appearance. Solid parquet wood flooring is more traditional. Engineered wood flooring is composed of layers with a wood species forming the top flooring surface, and two or more under layers of wood running at 90° to each other. The crisscrossed layers increase stability which enables the product to be installed over all types of sub floors and to be used with underfloor heating.

Components:

Kiln dried sawn timber

Adhesive for flooring

Cement floor screed

Minimum thickness	0.015 m
Default thickness	0.025 m
Maximum thickness	0.025 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	143 MJ/m^2

5.11 - Plant fibre (Seagrass, sisal, coir or jute) carpet

Description

Natural flooring has low embodied energy but it has some disadvantages. It can be sensitive to changes in environment or atmosphere; the product may expand or shrink if fitted in an area such as a bathroom or kitchen where there is constant change in temperature. Natural fiber flooring may also stain easily. Also, grass contains its own natural oils which makes it slippery on stairs. It’s also not as hardwearing as other natural-fiber floorings such as sisal or coir.

Components:

- Plant fibre carpet
- Adhesive for flooring
- Carpet underlayment
- Cement floor screed

Minimum thickness	0.003 m
Default thickness	0.005 m
Maximum thickness	0.005 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	59 MJ/m^2

5.12 - Cork Tiles

Description

Cork has low embodied energy and is environmentally friendly. It can be harvested from the same tree for about two hundred years. Harvesting is done with minimal impact on the environment and no trees are cut down to manufacture cork products. Advanced coating technology provides highly resistant and long-lasting protection even in high traffic environments.

Components:

Cork tiles

Adhesive for flooring

Cement floor screed

Minimum thickness	0.005 m
Default thickness	0.010 m
Maximum thickness	0.015 m
Default reinforcement	0 kg / m^2
Embodied energy at default thickness	45 MJ/m^2

5.13 – Re-use of Existing Flooring

Description

Re-using an existing material avoids the use of new materials and thus of embodied energy. The re-use of existing materials option in EDGE is highly desirable and assigned an embodied energy value of zero (0). Materials greater than five years old will be considered as embodied-energy neutral, which can be indicated as "re-use of existing materials" within the EDGE App.

Components:	Embodied energy at default thickness	
Re-use of existing flooring		0 MJ/m^2

M06 – WINDOW FRAMES

6.01 – Aluminium

Description

The advantage of using metal window frames is that they are strong, light, and require less maintenance than other materials used for window frames. However as metal conducts heat very well, the thermal performance of metal windows is not as good as other materials. To reduce heat flow (indicated by the U-value), metal frames can use strategies such as a thermal break between the inside and outside of the frame.

The two metals typically used for window frames are aluminium or steel. Aluminium is lighter weight and does not rust like a ferrous metal such as steel, but the embodied energy is much higher. Steel windows are heavier and require some maintenance to protect from rust (unless stainless steel is used).

Components:	Embodied energy at default thickness	
Extruded aluminium window frame		1,636 MJ/m^2

6.02 – Steel

Description

The advantage of using metal window frames is that they are strong, light, and require less maintenance than other materials used for window frames. However as metal conducts heat very well, the thermal performance of metal windows is not as good as other materials. To reduce heat flow (indicated by the U-Value), metal frames can use strategies such as a thermal break between the inside and outside of the frame.

The two metals typically used for window frames are aluminium or steel. Aluminium is lighter weight and does not rust like a ferrous metal such as steel, but the embodied energy is much higher. Steel windows are heavier and require some maintenance to protect from rust (unless stainless steel is used).

Components:	Embodied energy at default thickness	763 MJ/m^2
Steel window frame		

6.03 – Timber

Description

Timber window frames insulate relatively well, but they also expand and contract in response to weather conditions. Timber frames can be made from either soft or hard wood. Softwood frames are much cheaper, but are likely to require more regular maintenance. The maintenance required can be reduced by using aluminium or vinyl cladding on timber frames, but that reduces the thermal performance, especially if aluminum is used. Also see 6.05.

Components:

Timber window frame

Embodied energy at default thickness: 360 MJ/m^2

6.04 - UPVC

Description

UPVC (unplasticised polyvinyl chloride) window frames are extruded with

ultraviolet light (UV) stabilizers to keep sunlight from breaking down the material. UPVC window frames are low maintenance as they do not require painting. UPVC frames with insulated cavities have very good thermal performance.

Components:

UPVC window frame

Embodied energy at default thickness	829 MJ/m^2

6.05 - Aluminium clad timber

Description

Aluminium cladding is fixed to wooden framing members with a space for ventilation purposes. Timber and aluminium have high embodied energy. The extruded aluminium sections are designed for strength and rigidity, to prevent deformation at the fastening points. Often used in commercial applications, these windows are also suitable for residential applications where low maintenance is important, such as social housing, and high-rise developments.

Components:	Embodied energy at default thickness	
Extruded aluminium frame cladding Timber window frame		615 MJ/m^2

6.06 – Re-use of Existing Window Frames

Description

Re-using an existing material avoids the use of new materials and thus of embodied energy. The re-use of existing materials option in EDGE is highly desirable and assigned an embodied energy value of zero (0). Materials greater than five years old will be considered as embodied-energy neutral, which can be indicated as "re-use of existing materials" within the EDGE App.

Components:	Embodied energy at default thickness
Re-use existing window frames	0 MJ/m^2

M07 & M08 – INSULATION

7.01 – Polystyrene

Description

Polystyrene has the highest embodied energy per square meter of any other insulation type. There are two types of polystyrene insulation:

(1) **Expanded Polystyrene (EPS)** insulation is made from small beads of polystyrene that expand when heated and mixed with a blowing agent (usually pentane). Expanded polystyrene is available in board form or as beads. Boards are produced by placing the beads in moulds and heating them in order to fuse the beads together. Typical applications of EPS boards are for insulation of walls, roofs, and floors. Polystyrene beads are frequently used as cavity fill in masonry walls.

(2) **Extruded Polystyrene (XPS)** is made by mixing polystyrene with a blowing agent under pressure and forcing it through a die. As it emerges from the die it expands into foam; it can then be shaped and trimmed. XPS is slightly stronger than EPS, and although it is used in many of the same applications as EPS, it is particularly suitable for use in humid consitions such as below ground, or where extra loading and/or impacts might be anticipated.

Components:

Expanded polystyrene insulation (EPS)

Minimum thickness	0.010 m
Default thickness	0.050 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	83 MJ/m^2

7.02 - Mineral Wool

Description

Rock-based mineral wool is made by melting rock and recycled steel slag and spinning it into fibers. The insulation is available in different densities depending on the required functionality. Higher densities provide better sound insulation but poorer thermal insulation. Applications include masonry cavity walls, timber frame walls, and insulation for roof rafters, lofts, and suspended floors. Mineral wool has low resistance to moisture.

Components:

Mineral wool insulation

Minimum thickness	0.010 m
Default thickness	0.050 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	30 MJ/m^2

7.03 - Glass Wool

Description

Glass wool also known as fibre glass insulation is similar to rock wool, although it uses different raw materials and a different melting process. Glass wool is made from silica sand, recycled glass, limestone, and soda ash. Higher densities provide better sound insulation but poorer thermal insulation. Applications include masonry cavity walls, timber frame walls, and insulation for roof rafters, lofts, and suspended floors.

Components:

Fibre glass wool insulation

Minimum thickness	0.010 m
Default thickness	0.050 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	30 MJ/m^2

7.04 - Polyurethane

Description

Polyurethane (PUR), a closed-cell plastic insulation, is formed by reacting two monomers in the presence of a blowing agent catalyst (polymerisation). Polyisocyanurate foam (known by its short names PIR or PIC) is essentially an improvement on polyurethane (there is a slight difference in the constituents and the reaction is conducted at higher temperatures); it is is more fire-resistant and has a slightly higher R-Value.

Applications include wall, floor, and roof insulation. Polyurethane is also popular in laminate form in SIPs (structural insulated panels) and as an insulation backing to rigid boarding such as plasterboard.

Components:

Polyurethane rigid foam insulation

Minimum thickness	0.010 m
Default thickness	0.050 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	197 MJ/m^2

7.05 - Cellulose

Description

Four major types of loose-fill cellulose products have been developed for differing uses in a building under a variety of brand names. These are generally characterized as:

1. Dry cellulose

2. Spray applied cellulose

3. Stabilized cellulose

4. Low dust cellulose

1. **Dry cellulose** is used in retrofits of old homes by blowing the cellulose into holes drilled into the tops of the walls. It can also be blown into a new wall by using temporary retainers or netting that is clamped in place then removed once the cellulose has reached the appropriate density. This form of application does settle as much as 20%. The R-value of the cellulose should be cosidered after settling occurs. In addition, a dense-pack option can be used to reduce settling and further minimize air gaps. Dense-pack places pressure on the cavity, and should be done by an experienced installer. Loose fill in walls is an antiquated technique of using cellulose in wall cavities. The home performance industry and its accrediting bodies support the dense-pack standard of insulating wall cavities, which does not settle. This method stops the stack effect and convective loops in wall cavities.
2. **Spray-applied cellulose** is used for applying cellulose to new wall construction. The differences are the addition of water to the cellulose while spraying as well as adding a moisture retardant such as chlorine to prevent mold cultures. In some cases the insulation might also mix in a very small percentage of adhesive or activate a dry adhesive present in the cellulose. Wet-spray allows application without the need for a temporary retainer. In addition, wet-spray allows for an even better seal of the insulated cavity against air infiltration and eliminates settling problems. Wet-spray installation requires that the wall be allowed to dry for a minimum of 24 hours (or until maximum of 25% moisture is reached) before being covered.
3. **Stabilized cellulose** is used most often in attic/roof insulation. It is applied with a very small amount of water to activate an adhesive. This reduces settling and decreases the amount of cellulose needed. This can prove advantageous at reducing the overall weight of the product on the ceiling drywall helping prevent possible sag. This application is ideal for sloped roofs and has been approved for 5:12 (41.66%) slopes.
4. **Low-dust cellulose**: Nuisance levels of dust are created during application of most types of dry insulation causing the need for simple dust masks to be worn during installation. This kind of cellulose has a small percentage of oil or similar dust dampener added to reduce dust during application. This may also be appropriate for homes where people are sensitive to newsprint or paper dust (though new dust will not be created after installation).

INSULATION

Components:		Minimum thickness	0.010 m
Cellulose insulation		Default thickness	0.050 m
		Maximum thickness	0.300 m
		Default reinforcement	0.0 kg / m^2
		Embodied energy at default thickness	4 MJ/m^2

7.06 - Cork

Description

Cork has low embodied energy and is environmentally friendly. It can be harvested from the same tree for about two hundred years. Harvesting is done with minimal impact on the environment and no trees are cut down to manufacture cork products.

Components:

Cork insulation

Minimum thickness	0.010 m
Default thickness	0.050 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	23 MJ/m^2

7.07 - Woodwool

Description

Woodwool boards have been used in buildings for decades and are a popular substrate for lime plaster. Strands of wood, bound together with a small proportion of Portland cement, provide a good background for lime plasters, eliminate thermal bridges in pillars, beams, inter-storey facings, and radiator niches and provide insulation of flat and sloping roofs; provide acoustic insulation of walls and insulation from floor noise; as well as fire resistant coverings.

Components:

Woodwool board insulation

Minimum thickness	0.010 m
Default thickness	0.050 m
Maximum thickness	0.300 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	577 MJ/m^2

7.08 - Air gap <100mm wide

Description

In principle, the use of cavities is similar to the use of an insulating material. Air is a poor conductor of heat. Therefore, still air trapped in an air space between two layers of a wall or roof acts as a barrier to heat transfer.

Components:

Air space <100mm

Minimum thickness	0.025 m
Default thickness	0.075 m
Maximum thickness	0.100 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	0 MJ/m^2

7.09 - Air gap >100mm wide

Description

In principle, the use of cavities is similar to the use of an insulating material. Air is a poor conductor of heat. Therefore, still air trapped in an air space between two layers of a wall or roof can act as a barrier to heat transfer.

However, gaps larger than 100mm encourage convection and are not effective.

Components:

Air space >100mm

Minimum thickness	0.100 m
Default thickness	0.120 m
Maximum thickness	0.250 m
Default reinforcement	0.0 kg / m^2
Embodied energy at default thickness	0 MJ/m^2

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