ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A1*

Owner of the Declaration	**SHERA Public Company Limited**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-MFC-20220122-IBC1-EN
Issue date	04/10/2022
Valid to	03/10/2027

SHERA fibre cement products

SHERA Public Company Limited

Institut Bauen und Umwelt e.V.

www.ibu-epd.com | https://epd-online.com

ECO PLATFORM EPD VERIFIED

1. General Information

SHERA Public Company Limited

Programme holder
IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number
EPD-MFC-20220122-IBC1-EN

This declaration is based on the product category rules:
Fibre cement / Fibre concrete, 01.2019
(PCR checked and approved by the SVR)

Issue date
04/10/2022

Valid to
03/10/2027

Dipl. Ing. Hans Peters
(chairman of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V.))

SHERA fibre cement building products

Owner of the declaration
SHERA Public Company Limited
59 Moo 12 Saraburi-Lomsak Road K.M. 16,
Chongsarika Sub-District, Pattananikom District,
Lopburi 15220 Thailand.

Declared product / declared unit
Per 1000 kg of SHERA fibre cement building products

Scope:
This EPD declaration and background report covers the 26 fibre cement building products in six product groups i.e. Ceiling, Wall, Floor, Decorative, Accessories and Roof. These products are based on a weighted average of different SHERA fibre cement building products manufactured by SHERA Public Company Limited, and produced in the manufacturing plant located in Pattananikom, Lopburi province, Thailand in which the production data from January 2019 to December 2019 were recorded. Life cycle assessment (LCA) was conducted based on the cradle-to-gate approach (Module A1-A3), where the whole production phase of the SHERA fibre cement building product was considered in this study.

The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of *EN 15804+A1*. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard *EN 15804* serves as the core PCR
Independent verification of the declaration and data according to *ISO 14025:2011*
☐ internally ☒ externally

Matthias Klingler
(Independent verifier)

2. Product

2.1 Product description/Product definition

All (of) SHERA Fibre Cement products are composed of Portland cement, silica sand, fly ash, cellulose fibre, and flue gas desulfurization (FGD) gypsum or synthetic gypsum. SHERA fibre cement products, therefore, are cement-based composites, that are reinforced with cellulose fibre. SHERA products, which are applied in this EPD, are five autoclaved product groups, and one air-dried product group, which is the Roof group. SHERA Fibre Cement products have been either finished or painted. The declared products include:

1) Ceiling product group:
1.1) Ceiling board 1.2) Cornice 1.3) Strip

2) Wall product group:
2.1) Plank 2.2) Wallboard 2.3) Splendid

3) Floor product group:
3.1) Flooring board 3.2) Floor plank 3.3) Skirt 3.4) Stair

4) Decorative item product group:
4.1) SHERA Ply 4.2) SHERA Wood Air Vent 4.3) SHERA Safety Plank 4.4) Fence 4.5) Decorative Wood Plank

5) Accessories group:
5.1) Eave 5.2) Eaves Filler Unit

6) Roof group: 6.1) Slate 6.2) Corrugated Roof 6.3) Zedar Shake

For the use and application of the product, the respective national provisions at the place of use are applied. For example, in Germany, those include the building codes of the federal states and the corresponding national specifications.

2.2 Application

SHERA Fibre Cement products are used for residential, commercial, and industrial buildings.

2.3 Technical Data

Technical data

Name	Value	Unit
Thermal conductivity ISO 8336	0.11 - 0.12	W/(mK)
Calculation value for thermal conductivity	N/A	W/(mK)
Water vapour diffusion resistance factor (a)	N/A	-
Swelling (air-dry to water-saturated) ASTM C1185 (2016), Water absorption	0.07	mm/m
Sound absorption coefficient (b)	N/A	%
Gross density ASTM C1185-08 (2016), Density	1371.58	kg/m^3
Compressive strength	N/A	N/mm^2
Tensile strength	N/A	N/mm^2
Flexural strength ASTM C1185-08 (2016), Flexural strength	14.53	N/mm^2
Modulus of elasticity (c) ASTM C1185-08 (2016), Flexural strength	14.53	N/mm^2
Moisture content at 23 °C, 80% humidity ASTM C1185-08 (2016)	6.49 - 7.66	M.-%
Coefficient of thermal expansion	N/A	$10^{-6}K^{-1}$
Chemical resistance	N/A	-
Ageing resistance (d) ASTM C1185, Heat Rain test	Passed	-
Permanent temperature resistance ASTM C1185-08 (2016)	65	°C

Remark:

(a) water vapour diffusion resistance factor might be possibly substituted by property of Water Absorption, a result of ASTM C1185 test. The value of water absorption is 29.55 %, which indicates that SHERA products reach the water saturated level at a weight increase for 29.55 % from dried condition. The test period of the specimen´s submergence is 48 hours.

(b) The capacity of sound absoprtion has been tested on the declared product through ChulaUnisearch, the laboratory of Chulalongkorn university. The test result showed that the sound absorption coefficient of declared product has been classified as STC 45.

(c) the value of modulus of elasticity is used referring to the flexural strength, which derived from ASTM C1185 (2016)*.*

(d) the result of ASTM C1185, Heat Rain test might substitute the ageing resistance. The heat rain test is a durability test of the building product by simulating the severe weather (high temperature and high water pressure). The result showed that there is no sign of cracking, fungi growth, or any water penetration.

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

2.4 Delivery status

Product Standard/ Technical approval

The SHERA Fibre Cement products have made of fibre cement are delivered in standardized formats with different dimensions. The thickness has a range from 3.2 to 35 mm. Width has a range from 0.05 to 1.22 m. Length has a range from 1.2 to 4.0 m. They are delivered on pallets with a maximum weight of up to 15 kilograms

2.5 Base materials/Ancillary materials

The products can be manufactured in the following sizes.

Name	Value	Unit
Portland cement	30 - 32	% of declared product by weight
Silica Sand	29 - 31	% of declared product by weight
Cellulose fibre	5 - 6	% of declared product by weight
Fly ash	3	% of declared product by weight
FGD gypsum	24 - 25	% of declared product by weight

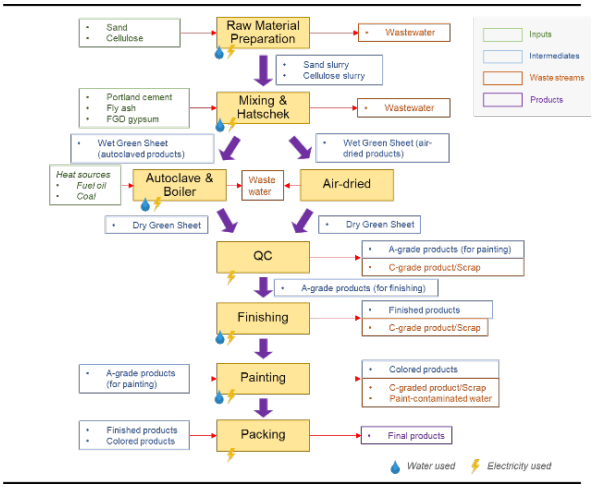
Remark:

1) This product/article/at least one partial article contains substances listed in the candidate list (date: 30.09.2022) exceeding 0.1 percentage by mass: ***no.***

2) This product/article/at least one partial article contains other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: ***no.***

3) Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): ***no.***

2.6 Manufacture



There are five raw materials i.e. Portland cement, silica sand, fly ash, cellulose fibre, and FGD gypsum, used as base materials of producing SHERA fibre cement products. Only sand and cellulose fibre are needed to be pre-processed. The unbleached cellulose fibre is refined and washed by re-pulping, and bleaching with NaOH, respectively. The sand is also prepared by blending with water to form the sand slurry. Then these are fed to combine with the rest raw materials to form a mixture at the mixing unit. The mixture is then fed to the Hatschek unit, where the fibre cement mixture is produced, called 'the moist solid sheet'. The moist solid sheet is transferred onto rollers to reduce the size of the product to achieve the desired thickness. The output is called "Wet Green Sheet". Then, the Wet Green Sheet is dried to become 'Dry Green Sheet'. The drying process has two operations i.e. Autoclaving unit for building product, the process uses an additional heat source and air-drying for the roof product. After the moisture content has reached the desired level, 13-15 %, the Dry Green Sheet is then inspected at the QC unit, and classified into three quality grades as follows:
A Grade: Products fit for sale;
B Grade: Products with minor defects that will be re-touched/re-finished to become A-grade. The process for re-touched/re-finished B-grade products to be A-grade is included in the finishing process;
C Grade: Products which are not fit for sale. C-grade products will be either recycled or reused as pallet for supporting the transportation of SHERA products to client/customer.
If the products have been verified by QC unit, the A-graded product is either finished or coloured. Then, the final unit is packing. All of the autoclaved products are packed by using shrink film to cover the external surface, while the roof product, only Zedar shake, is packed by using paper cardboard to support the edge of the merchandise. The packed products are now able to be delivered to the client or customer.

2.7 Environment and health during manufacturing

SHERA manufacturing plant, located at Phatthana Nikhom District, Thailand, has been certified for *ISO14001*: Environmental Management Systems Specifications. The environmental measures dealing with air emissions, wastewater, and solid waste have been developed.

Wastewater: Non-paint contaminated wastewater is treated by designated treatment plant and 100 % recycled back into the manufacturing process. Paint-contaminated wastewater is properly treated by using common and non-hazardous chemical agents to separate the paint element out of wastewater.

Solid Waste: Non-contaminated wastes, which are C-grade products and non-paint-contaminated sludge are either reused or recycled. C-graded products have been reused as a pallet for supporting SHERA's merchandise. Non-paint-contaminated sludge has been used as an input for the production process. The remained sludge from non-paint-contaminated wastewater has been used for land application in the factory. The paint-contaminated sludge is treated by the external facility, as is the partnership to treat the contaminated sludge in an appropriate way.

Air emission: Air emissions control technology and equipment (e.g. dust collector, scrubber) are installed to collect dust and fumes from the manufacturing process. Air emissions monitoring program is implemented in accordance with Thailand's *Factory of Act B.E.2535* (1992).

Health: The level of exposure to noise, dust, and chemicals in the workplace is monitored in accordance with Thailand Labor Protection Act B.E. 2562 (2019). Personal protection equipment (PPE) is provided to all employees (e.g. earplugs, dust mask, respirator, etc.) where recommended.

2.8 Product processing/Installation

Fibre cement sheet is cut by using a high-pressure water jet. The benefit of using the high-pressure water jet is that it prevents the dust as a result of cutting apart the cement-based sheet. Personal protection equipment (PPE) is provided to all employees (e.g. earplugs, dust mask, respirator, etc.) where recommended.

2.9 Packaging

SHERA utilize only two types of packing materials i.e. LDPE (low density polyethylene) and paper cardboard. The LDPE has been applied to building products, while the paper cardboard has been used to support the sensitive roof product i.e. Zedar Shake. LDPE is easy to recycle. The paper cardboard is a fundamentally recyclable material. It can be either disposed of on-site or reused.

2.10 Condition of use

SHERA fibre cement building products are designed for both interior and exterior applications. Based on current knowledge, no hazards to water, air and soil arise from installing or using SHERA fibre cement products according to their intended use. The product is resistant to water, oil, seawater, and diluted acid and bases, and will not disintegrate when in contact with these liquids.

2.11 Environment and health during use

SHERA fibre cement board, as a representative of SHERA fibre cement products, has been tested for the total volatile organic compound (TVOC) and Formaldehyde emission according to the *ASTM D5116-17:* Standard Guide for Small-Scale Environmental Chamber Determinations of Organic

Emissions from Indoor Materials/Products. The result showed that both the TVOC emission rate and the formaldehyde emission rate are lower than the criteria set by *Singapore Green Label Category 41*. Additionally, the elemental analysis also showed that the heavy metals e.g. Sb, Cu, Se, Sn, Hg, Pb, etc., are not presented in the SHERA board.

Furthermore, the products do not have dermatological effects during production or use because Cr(VI) in Portland cement is generally present in trace amounts and it is not health risk in the solution form.

2.12 Reference service life

The use phase is not evaluated in this environmental product declaration. Hence, the reference service life is not relevant to this EPD because the declared module of this EPD is A1-A3.

2.13 Extraordinary effects

Fire

Floor Plank, as representatives of all SHERA fibre cement products has been tested in accordance with *DIN EN 13501-1:2007 + A1:2009*, the result would be as follow:

Fire protection

Name	Value
Building material class	A2
Burning droplets	d0
Smoke gas development	s1

Water

SHERA fibre cement products are not composed of any hazardous compositions, as a result of a test according to*ASTM D5116-17*. The ingredients are also firmly embedded in the fibre cement mixture. Therefore, the leakage of heavy metals or hazardous substances will not be presented when the products are exposed to the unforeseeable influence of water such as flooding.

Mechanical destruction

Not relevant

2.14 Re-use phase

Only removable fastening devices e.g. screw, stud, bolt, etc. have been used in all of SHERA products to combine many parts to develop the infrastructure of the living place. Polyurethane sealant has been applied for closing the minor gaps of joints (of the parts). Therefore, it is easy to disassemble and reuse for other applications.

2.15 Disposal

SHERA fibre cement materials scraps/wastes are classified as non-hazardous wastes under Thailand *Factory of Act B.E.2535 (1992)*, Disposal of Waste and Usable Material regulation. Eurpoean Waste Code: 10 13 11 wastes from cement-based composite materials without asbestos.

2.16 Further information

https://www.shera.com/en/

3. LCA: Calculation rules

3.1 Declared Unit

The life-cycle assessment refers to 1 ton of SHERA fibre cement products. The declared indicators for the inventory and impact assessment were determined on the basis of an average formulation and the data on production at the manufacturing plant in Pattananikom district, Lopburi.

Declared unit

Name	Value	Unit
Declared unit	1	t
Gross density	1371	kg/m^3

3.2 System boundary

Type of the EPD: cradle to gate
The LCA refers to the stage of product development i.e. modules A1 to A3. The process after the product has been developed is not accounted for.
A1 – raw material extraction, processing
A2 – transportation of raw materials to the manufacturer
A3 – All of manufacturing operations starting from raw materials preparation to packing process.
Environmental impact as a result of energy production has been included in the LCA. The production of ancillary materials i.e. painting materials, LDPE film, paper cardboard, and production of chemical agents used to treat paint-contaminated wastewater have also been included in the LCA analysis.

3.3 Estimates and assumptions

The LCA interpretation of all processes were considered based on the default values in the generic databases e.g. *Ecoinvent v3.8* unit process. Customization of some process or materials might be conducted, mostly related to the default of the electricity mix. The electricity mix might be changed to a country-specific value, the Thailand region.

3.4 Cut-off criteria

The cut-off criterion is set at 1 % of renewable and non-renewable primary energy usage and 1 % of total mass of that unit process as a materiality threshold. Emissions attributable to fly ash were neglected, as its economic value represents less than 1 % of the overall revenue of the power plant. This cut-off criteria was also applied for FGD gypsum, since the economic value of FGD gypsum from the production source is less than 1 %.

3.5 Background data

Data used in this study can be grouped into 4 types – i.e. site-specific, country-specific, theoretical, and generic data.

Data	Type of LCI Data
Raw materials, ancillary materials, secondary materials, and packaging materials acquisition	Generic data provided in v3.8
Raw materials, ancillary materials, secondary materials, and packaging materials transportation	Theoretical value, point-to-point distance provided by the Google map and SeaRates.com
	Type of vehicles for all transportation are country specific data
Thailand grid electricity	Country specific data
Manufacturing process	Site specific data and theoretical value

3.6 Data quality

All manufacturing data was recorded or calculated within the measurement system of SHERA manufacturing plant. Generic data provided by *Ecoinvent v3.8* Unit Process are used for upstream production. Generic data provided by the Thai National Life Cycle Inventory Database were used for transportation and grid electricity. The background data that was used was last revised less than 5 years ago.

3.7 Period under review

Data collection period: January 2019 – December 2019

3.8 Allocation

For all considered inputs and outputs, resource use, electricity use, and water use have all been allocated to the mass of the final product such that no material or energy flow is omitted or double-counted.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account.

Background data from *Ecoinvent v3.8* (data updated 2021) was used.

4. LCA: Scenarios and additional technical information

Not applicable

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED; MNR = MODULE NOT RELEVANT)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	MND	MND	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A1: 1000 kg SHERA fibre cement building products

Parameter	Unit	A1-A3
Global warming potential	[kg CO_2-Eq.]	490.60
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	0.00
Acidification potential of land and water	[kg SO_2-Eq.]	1.96
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	0.39
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	0.06
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	0.00
Abiotic depletion potential for fossil resources	[MJ]	5286.74

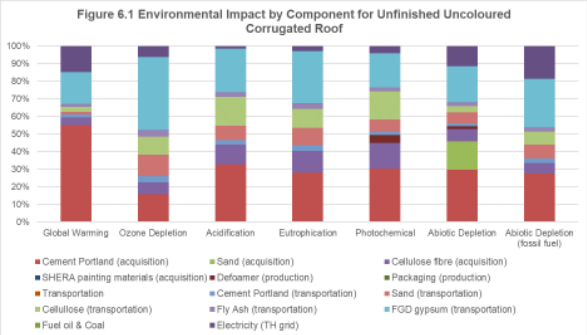
RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A1: 1000 kg SHERA fibre cement building products

Parameter	Unit	A1-A3
Renewable primary energy as energy carrier	[MJ]	0.00
Renewable primary energy resources as material utilization	[MJ]	141.00
Total use of renewable primary energy resources	[MJ]	141.00
Non-renewable primary energy as energy carrier	[MJ]	5050.00
Non-renewable primary energy as material utilization	[MJ]	233.00
Total use of non-renewable primary energy resources	[MJ]	5290.00
Use of secondary material	[kg]	267.00
Use of renewable secondary fuels	[MJ]	0.00
Use of non-renewable secondary fuels	[MJ]	587.00
Use of net fresh water	[m^3]	1.80

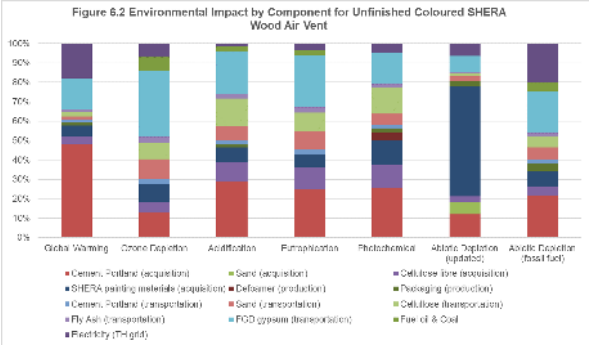
RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A1: 1000 kg SHERA fibre cement building products

Parameter	Unit	A1-A3
Hazardous waste disposed	[kg]	22.40
Non-hazardous waste disposed	[kg]	3.82
Radioactive waste disposed	[kg]	0.00
Components for re-use	[kg]	32.00
Materials for recycling	[kg]	425.00
Materials for energy recovery	[kg]	0.00
Exported electrical energy	[MJ]	0.00
Exported thermal energy	[MJ]	0.00

6. LCA: Interpretation



In **Figure 6.1**, the impact results of all impact categories show the elements that contribute the impacts more than 1 % of total impacts.
For the result of hotspot analysis, most of the environmental impact categories i.e., **ODP**, **AP**, **EP**, and **ADPF**, have the hotspot on the transportation stage (A2), which is significantly higher than the other two stages (A1 and A3). This is because the Unfinished Uncoloured Corrugated Roof is an air-dried and uncoloured product, which contributes to lower consumption of energy and chemicals. Therefore, the environmental impacts of transportation are relatively the highest among the three stages.
As above, the environmental impacts of the Unfinished Uncoloured Corrugated Roof at the transportation stage for **ODP**, **AP**, **EP**, **ADPE**, and **ADPF** categories, are 70.74 %, 54.21 %, 56.02 %, and 47.43 %, respectively. The transportation of FGD gypsum is the highest element in these impact categories. FGD gypsum that is used as a raw material of the building product is the by-product of Mae Moh power plant, the power facility under responsibility of *Electricity Generating Authority of Thailand* (EGAT). The distance from Mae Moh power plant to Lopburi, where manufacturing facility of SHERA locates, is 547 km. The environmental load, because of the FGD gypsum transportation, will be relatively high to the other material transportation.
For the rest of environmental impact categories i.e., **GWP**, **POCP**, and **ADPE** the hotspot impact of these categories is raw material acquisition (A1), which it covers for 59.16 %, 49.16 %, and 51.34 % respectively. The main contributor of **GWP**, **POCP**, and **ADPE** impact categories is Portland Cement, which accounts for 54.70 %, 30.30 %, and 27.90 %, respectively. However, for **ADPE** impact category, sand is one of the major contributors (account for 15.40 %), since the sand mining process potentially relates to destruction of landscape and water pollution. The rationale of high coverage of Portland Cement contributing to these impacts is that cement manufacturing conditions require high process temperatures, which is derived from a very high level of energy consumption, to achieve calcination process. The process condition is particularly favourable for the formation of nitrogen oxides (NOx) because of the high process temperatures and oxidizing atmospheres involved, which it contributes significantly to ozone formation.



In **Figure 6.2**, the impact results of all impact categories show the elements that contribute the impacts more than 1 % of total impacts.
Unfinished Coloured SHERA Wood Air Vents have more manufacturing process than Unfinished Uncoloured Corrugated Roof, as the SHERA Wood Air Vent is an autoclaved and painted product, which consumes more energy and uses more chemicals than the Corrugated Roof product.
The majority of environmental categories still maintain the hotspot at the same stage with the Unfinished Uncoloured Corrugated Roof. **ODP** and **EP** are the impact categories showing magnitude at the transportation stage (57.88 % and 49.47 %, respectively) being significantly higher than the material acquisition (27.04 % and 41.66 %, respectively). This show that the impact at transportation to be higher than the material acquisition, where the consumption of energy and chemicals are increased.
For **GWP**, **POCP**, and **ADPE** impact categories, the hotspot is at the raw material acquisition stage, which accounts for 58.18 %, 53.88 %, and 79.37 %, respectively. **GWP**, **POCP**, and **ADPE** impact categories have Portland cement as the highest contributor, which on average covers 24.89 % of total impacts. However, the main contributor for **ADPE** is different. It includes the pigment production, which accounts for 55.81 % of total impact, as the highest contributor. This is because the pigment has titanium dioxide as a material composition.
However, the impact difference between material acquisition stage and transportation stage of **AP** and **ADPF** categories is tiny. Material acquisition phase and transportation stage of **AP** are 47.15 % and 47.21 %, respectively, while for **ADPF** 38.02 % and 36.98 %, respectively. Then, the hotspot of these two categories could be both raw material acquisition stage and transportation stage. The transportation of FGD gypsum is the highest element in these impact categories. FGD gypsum that is used as a raw material for the building product is the by-product of Mae Moh power plant, the power facility under the responsibility of *Electricity Generating Authority of Thailand (EGAT*). The distance from Mae Moh power plant to Lopburi, where the manufacturing facility of SHERA is located, is 547 km.

7. Requisite evidence

Methodology

EU Directorate General for Environment, Nuclear Safety and Civic Protection's Document 112:
"Radiological Protection Principles concerning the Natural Radioactivity of Building Materials", sets out a screening process whereby building materials which, in their usual context, do not lead to a contribution of more than 0.3 millisieverts per annum do not generally require further assessment. Typical activity concentrations (in Becquerels per kilogram) for certain building materials and industrial by-products used for building materials, are shown below in *Table7.1*

Table 7.1 Typical Activity Concentrations for Common Building Materials

Material	*Typical Activity Concentration (Bq/kg)*		
	Radium 226	*Thorium 232*	*Potassium 40*
Concrete	*40*	*30*	*400*
Gypsum	*10*	*10*	*80*
Fly ash	*180*	*100*	*650*
*Sand**	*20*	*30*	*530*

** From a study of Thai sand by Malain et al in Applied Radiation and Isotopes Volume 70 (2012) pp 1467 -1474*

An activity concentration index (I) is calculated from the relative contributions of the three principal radionuclides in the building materials:
I = CRa/(300 Bq/kg)+ CTh/(200 Bq/kg) + CK/(3000 Bq/kg)

EU Directorate General for Environment, Nuclear Safety and Civic Protection's Document 112 recommends that the maximum acceptable level I is 2 for superficial (non-bulk) materials. Cellulose fibres were excluded from assessment as it is of plant origin and are not of concern.

Assessment

Table 7.2 shows the weighted activity concentration index for each product type. Since there is no data on cement clinker in *EU Directorate General for Environment, Nuclear Safety and Civic Protection's Document 112*, values for fly ash have been used as a highly conservative estimate.

Table 7.2 Activity Concentration Indices

Product type	Activity Concentration Index
Ceiling group	0.30
Wall group	0.30
Floor group	0.30
Decorative group	0.31
Accessories group	0.30
Roof group	0.30

All of the SHERA product has range of activity concentration index below than 1.
All of the SHERA products has range of activity concentration index below than 1.

Conclusion: Based on data from the *EU Directorate General for Environment, Nuclear Safety and Civic Protection's Document 112* and a peer-reviewed journal paper, no further radiological testing is considered necessary for the declared products because our calculated I shown in Table 7.2 are below than 1.

7.2 Leaching

According to the test of evaluation for "SHERA Board", as a representative of all SHERA fiber cement products, the SHERA Board has been certified to comply with the *Singapore Green Label Category 41*. The test is in accordance to *ASTM D5116- 17*. The result of elemental analysis of heavy metal is shown in Table 7.3.

Table 7.3 Result of heavy metal composition

Antimony, Sb	Not detected[a]
Copper, Cu	Not detected[a]
Selenium, Se	Not detected[a]
Tin, Sn	Not detected[a]
Mercury, Hg	Not detected[a]
Lead, Pb	Not detected[a]
Cadmium, Cd	Not detected[a]
Chromium, Cr	Not detected[a]
Arsenic, As	Not detected[a]

[a] the detection limit was 50 ppm.

As shown in Table 7.3, it indicates that when the SHERA Board has contact with water, the leaching, as a result of contact, should not contain any heavy or hazardous materials.

7.3 VOC emissions

Optional for products, which are exclusively used in outdoor applications. Test procedure in line with the committee for health-related evaluation of building products/ Ausschuß zur gesundheitlichen Bewertung von Bauprodukten (*AgBB)* diagram indicating the measuring agency, date and results as a range of values. At least the following must be declared: Samples were tested in accordance to *ASTM D5116-17* – standard guide for small scale environmental chamber determinations of organic emissions from indoor materials/products". The sample testing was conducted by *TUV Singapore*.

AgBB overview of results (28 days [µg/m³])

Name	Value	Unit
TVOC (C6-C16)	< 0.1	mg/(m2-hr)
Formaldehyde Emission Rate	< 0.05	mg/(m2-hr)
Fluoropolymer additives (PTFE) (measured as F-)	Not detected (a)	-
Phosphogypsum (measured as PO43-)	Not detected (a)	-
Chlorine	Not detected (a)	-

Pentachlorophenol (PCP)	Not detected (b)	-
Ortho-phenyl phenol (OPP)	Not detected (b)	-
Tetrachlorophenol (TeCP)	Not detected (b)	-
Tar oils (benzo (a) pyrene)	Not detected	-
	(c)	
Analine based amines	Not detected (d)	-
Aziridine or polyaziridine	Not detected (d)	-

(a) detection limit was 100 ppm
(b) detection limit was 2 mg/kg
(c) detection limit was 50 ppm
(d) detection limit was 250 ppm

8. References

IBU 2021
Institut Bauen und Umwelt e.V.: General Instructions for the EPD programme of Institut Bauen und Umwelt e.V., Version 2.0, Berlin: Institut Bauen und Umwelt e.V., 2021
www.ibu-epd.com

ISO 14025
DIN EN ISO 14025:2011-10, Environmental labels and declarations – Type III environmental declarations – Principles and procedures (ISO 14025:2006); German and English versions EN ISO 14025:2011

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

Ausschuss für die gesundheitliche Bewertung von Bauprodukten (AGBB)
The Committee for Health-related Evaluation of Building Products

ANSYS simulation
Ansys Acoustics Simulation and Sound Design & Analysis conducted by Unisearch institute, under Chulalongkorn University

ASTM C1185
ASTM C1185 - 08(2016) Standard Test Methods for Sampling and Testing Non-Asbestos Fiber-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards

ASTM D3273
ASTM D3273-16, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber, ASTM International, West Conshohocken, PA, 2016

ASTM D5116-17
ASTM D5116-17, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products, ASTM International, West Conshohocken, PA, 2017, www.astm.org

ASTM E413
ASTM E413-16, Classification for Rating Sound Insulation, ASTM International, West Conshohocken, PA, 2016, www.astm.org

ASTM E84
ASTM E84-21a, Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM International, West Conshohocken, PA, 2021, www.astm.org

BS 476: Part 4
BS 476: Part 4: 1970, Fire tests on building materials and structures - Non-combustibility test for materials.

BS 476: Part 6
BS 476: Part 6: 1989 + A1: 2009, Fire tests on building materials and structures - Method of test for fire propagation for products

BS 476: Part 7
BS 476-7:1997: Fire tests on building materials and structures Method of test to determine the classification of the surface spread of flame of products

Ecoinvent v3.8
Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at: http://link.springer.com/10.1007/s11367-016-1087-8 www.ecoinvent.org

EN 13501-1
BS EN 13501-1:2018 Fire classification of construction products and building elements Classification using data from reaction to fire tests

EU Directorate General for Environment, Nuclear Safety and Civic Protection's Document 112
The European union: Radiological Protection Principles concerning the Natural Radioactivity of Building Materials
http://ec.europa.eu/energy/nuclear/radiation_protection/doc/publication/112.pdf

Eurpoean Waste Code: wastes from cement-based composite materials without asbestos.

Factory of Act B.E.2535
Department of Industrial Works, Ministry of Industry, Thailand

ISO 14001
ISO 14001:2015 Environmental management systems — Requirements with guidance for use

ISO 14040
DIN EN ISO 14040:2006-10, Environmental management - Life cycle assessment - Principles and framework (ISO 14040:2006)

ISO 14044

DIN EN ISO 14044:2006-10, Environmental management - Life cycle assessment - Requirements and guidelines (ISO 14040:2006)

ISO 8336
ISO 8336:2017 Fibre-cement flat sheets — Product specification and test methods

ISO 9001
ISO 9001:2015 Quality management systems — Requirements

Thailand Labor Protection Act B.E. 2562 (2019)
Labour Protection Act B.E. 2562 (2019), Department of Labour Protection and Welfare, Ministry of Labour, Thailand

Ordinance on Biocide Products No. 528/2012
REGULATION (EU) No 528/2012 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 May 2012 concerning the making available on the market and use of biocidal products

Thai National Life Cycle Inventory Database
LCI databases developed and owned by the National Metal and Materials Technology Center (MTEC), National Science and Technology Development Agency.
http://www.mtec.or.th/en/index.php
https://www.nstda-tiis.or.th/en/our-rd-activities/lci-database/status-of-national-lci-database/
http://www.thailcidatabase.net/index.php/thai-national-life-cycle-inventory-database

PCR 2021, Part A
Institut Bauen und Umwelt e.V., Königswinter (pub.): Product Category Rules for Building-Related Products and Services, Institut Bauen und Umwelt (IBU), Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report. 2021-09

PCR 2021, Part B
PCR Guidance-Texts for building-Related Products and Services, from the range of Environmental Product Declarations of Institut Construction and Environment e.V. (IBU)
(IBU), Part B: Requirements on the EPD for Fibre cement/ Fibre concrete. 2019-01
http://www.ibu-epd.com/

Singapore Green Label Category 41
Singapore Green Labelling Scheme (SGLS), Category 041: Panel Board.

Publisher
Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Tel +49 (0)30 3087748- 0
Fax +49 (0)30 3087748- 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

Programme holder
Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Tel +49 (0)30 - 3087748- 0
Fax +49 (0)30 – 3087748 - 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

Author of the Life Cycle Assessment
ERM-Siam Co, Ltd.
Bangkok City Tower 179
10120 Thungmahamek, Sathorn,
Bangkok
Thailand

Tel +66-2-679-5200
Fax +66-2-679-5209
Mail phakaporn.sukanan@erm.com
Web **www.erm.com**

Owner of the Declaration
SHERA (Public) Company Limited
Moo 12 Saraburi-Lomsak Road
K.M. 16 59
15220 Chongsarika Sub-District
Thailand

Tel +66-3-663-8888
Fax +66-3-663-8890
Mail wichit_p@sherasolution.com
Web **www.sherasolution.com**