Confederation of Indian Industry

Lifecycle assessment for cement sector

Lifecycle assessment is a holistic methodology to assess the environmental aspects of cement over its life cycle.
LCA helps to assess, compare and identify ways to reduce the environmental impacts and make cement more sustainable.

Grinding
Clinker is ground with additives and is sent for packing

Clinkerisation
The raw materials along with additives is processed in a kiln

Product use phase
Fuel use and emissions during construction is accounted in the phase

Raw material processing
Limestone is mined and sent for further processing to the plant

End of life
Energy usage and emissions after use phase is attributed to end of life

The functional unit is used as reference unit for each stage.
Mining → per tonne of limestone, Clinkerisation → per tonne of clinker, Grinding → per tonne of cement.

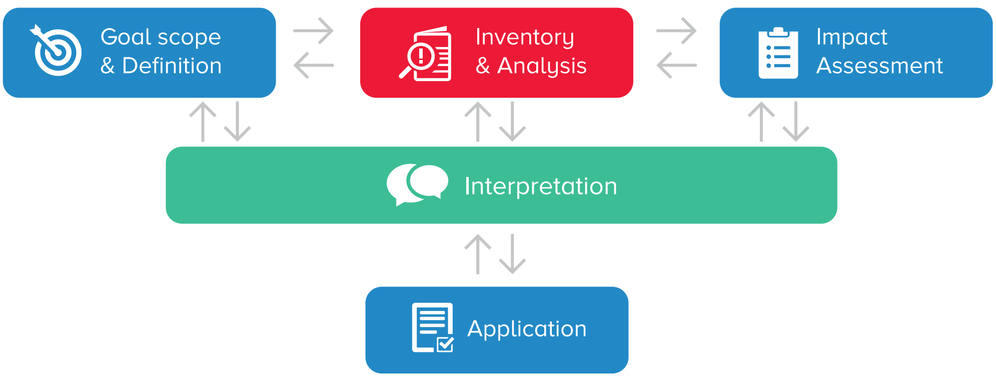
Phases of LCA

1 The **definition and scope** is determined along with data collection methods and presentation

2 The **life cycle inventory (LCI)** is completed through process diagrams, data collection and evaluation of the data

3 **Life cycle impact assessment** (LCIA) is determined with impact categories and subsequent results

4 The final **report** includes significant data, data evaluation and interpretation, final conclusions and recommendations



Benefits of LCA study

A systematic evaluation of the environmental impacts associated with cement

Analyzing the key issues & areas of improvement

Comparing alternatives to determine the most sustainable choice

Helps in communicating environmental performance to stakeholders through Environment Product Declaration

Development and optimization of production processes

Decision-making tool in policy formulation

Methodology

Goal & Scope:

To define the purpose of life cycle assessment is an important part of the goal definition. Goal definition should also define the intended use of the results and users of the result.

Scope of life cycle assessment sets the borders of the assessment: Inclusions in the system and detailed assessment methods that are to be used.

Different scope for a system:

Cradle to grave

Lifecycle of cement is considered from extraction of raw material till cement is disposed as waste at the end of life or use phase

Cradle to gate

Lifecycle is considered from mining until cement is dispatched from the factory, use phase impacts are not considered in this approach

Gate to gate

Impacts are assessed while the material is handled in the plant boundary.

Inventory analysis

A life cycle inventory (LCI) includes information on the environmental inputs and outputs associated with cement i.e. material used, energy, emission and waste

Input

- Limestone
- Water
- Electricity
- Fuels
- Capital equipment

Lifecycle of Cement

- Raw material processing
- Transportation
- Clinkerisation
- Grinding
- Use phase

Output

- Airborne emissions
- Water borne emissions
- Landfilled waste

Impact Assessments

Global impacts

Global warming

Snow cap melting, soil moisture loss, longer seasons, forest loss/change, wind and ocean pattern changes

Ozone depletion

Increased ultraviolet radiation

Resource depletion

Decreased resources for future generation

Regional impacts

Photochemical smog

Smog, decreased visibility, eye irritation, respiratory tract and lung irritation and vegetation damage

Acidification

Building corrosion, water body acidification, vegetation and soil effects

Local impacts

Human health

Increased morbidity and mortality

Terrestrial toxicity

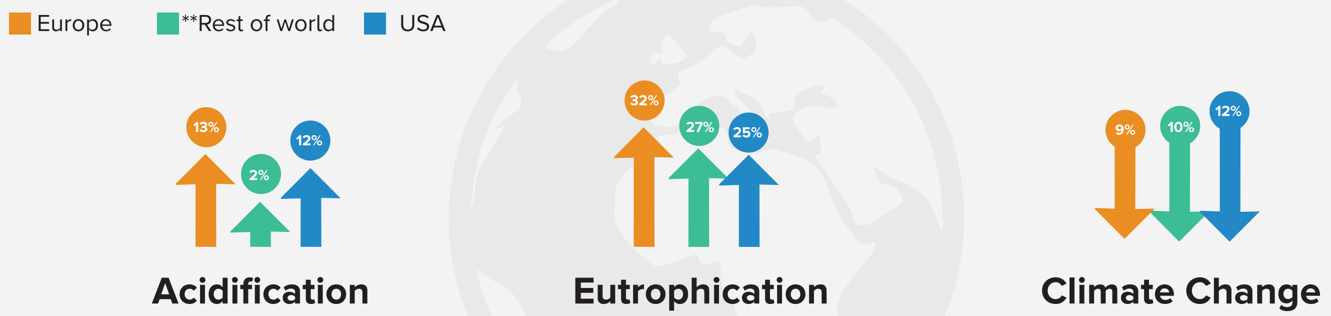
Decreased production and biodiversity, decreased wildlife population

Aquatic toxicity

Decreased aquatic plant and insect production, decreased biodiversity, decreased fish population

Impact by Indian clinker production*

Impact category	Unit	Indian	Europe	USA	Rest of the World
Acidification	kg SO_2 eq.	2.00	1.73	1.76	1.96
Eutrophication	kg PO_4-- eq.	0.32	0.22	0.24	0.23
Global warming (GWP100a)	kg CO_2 eq.	947	937	942	964
Photochemical oxidation	kg C_2H_4 eq.	0.033	0.060	0.059	0.070
Ozone layer depletion (ODP)	gm CFC-11 eq.	0.00594	0.0256	0.0256	0.024



Comparison of the environmental impacts of Indian clinker to clinker produced in Europe, USA and Rest of the world*

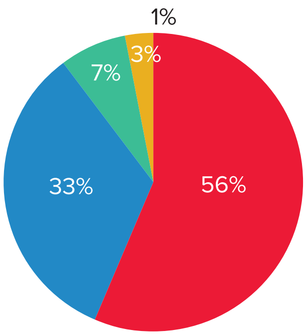
* Analysis based on data collected from more than 50% of total installed capacity of cement plants in India

**Rest of the World (RoW) is a geographical area. Datasets (activities) with this geography contain data for the rest of the world datasets which are not represented in the ecoinvent database.

Type of cement with lowest environment impact

Ordinary Portland Cement	Portland Pozzolana cement (PPC) with 11 to 35% fly ash	Portland Slag Cement (PSC) with 36 to 65% slag
Acidification, eutrophication and climate change all are highest amongst all types of cement due to high clinker factor	✓ Acidification and eutrophication of PPC is lowest among the three types of cement owing to minimum usage of electricity in manufacture cement ✓ Acidification and eutrophication of PPC is lesser when compared to OPC	✓ Portland Slag Cement (PSC) with 36% to 65% slag ✓ Climate change impact is the lowest in PSC and impact is lesser than OPC. This is due to reduced usage of clinker in PSC.

Alternate fuel and raw materials (AFR) usage in clinker



% share on thermal energy

- Municipal Solid Waste
- Biomass
- Tyre Waste
- Hazardous Waste
- Spent pot lining

AFR utilization in clinker production reduces the amount of CO_2 emitted due to increased substitution of alternate fuels and raw materials.

Benefits of using AFR

Impacts of increasing thermal substitution rate to 20%

CO_2 generated reduces by 5% per tonne of clinker

Reduces the ozone layer depletion potential by 8%

Reduces land required for landfill by 20%

Co-processing ranks higher in the hierarchy in comparison to disposal activities namely landfilling or incineration

Waste generated becomes a resource for other and due to its environmentally effective waste management system

Co-processing will support the country in moving towards "Zero waste to Environment"

Confederation of Indian Industry

P V Kiran Ananth
CII – Sohrabji Godrej Green Business Centre

kiran.ananth@cii.in | Ph: +91 -40-44185152

www.greenbusinesscentre.com