

Life Cycle Assessment of Concrete Buildings



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Abstract

In this research poster I will be looking at the Life cycle assessment of Concrete. The key purpose is to highlight each stage in concrete's life cycle and highlight the key energy inputs and outputs within the whole processes in line with the CEN/TC 350 'sustainability in construction' construction standards. The information has been based upon information on what goes on in industry combined with internet research. It has brought to my attention the amount of time, energy and Raw materials used during the production of concrete. One good aspect about the life cycle of concrete is the fact it lasts such a long time when in-situ and has many uses at the end of its life when crushed into hardcore and recycled. I think in the future there will be more useful ways to use the recycled stone and the whole process of manufacturing concrete will find more environmentally friendly ways of transporting the material across the globe.

Introduction

Concrete, being the most commonly used man-made material on earth is a popular component commonly used in building materials, bridges and infrastructure. It is also known that the construction industry is one of the main consumers of raw materials, with the concrete industry being worth \$37Billion. (Concrete Helper)

Over the years attention has been focused on solutions to avoid the use of raw materials and ordinary concrete to manage its environmental impacts. In order to achieve this it is possible to replace natural aggregates with recycled aggregates e.g. fly ash and furnace slag.

With figures rising it is suggested there is over 6 Millard tons of concrete is produced each year. (Watts, 2019)
The history of concrete spans over 5,000 years, and originates from the time of the Egyptian pyramids till now. (Al-Neshawy)

During this research poster I will be focusing on concrete buildings and concrete in its simplest form, from the extraction to end disposal. Being such a widespread and popular product there are various types of concretes that can be made with a variety of strengths, colors and features, these all require differing inputs and different outputs as necessary.

When looking at the environmental impact of a building it is important to assess all stages of the environmental life cycle, from extraction, material production, transport, building use, demolition and end disposal.



Construction Stage

A4-A5

A4 - Transport

After the production of concrete, various wagons transport the ready-mixed concrete to the construction sites. A concrete wagon can hold 8M2 of concrete meaning a number of wagons would be required for large amounts of concrete being needed adding to the fuel consumption of a vehicle, this will all be taken into account in the LCA.

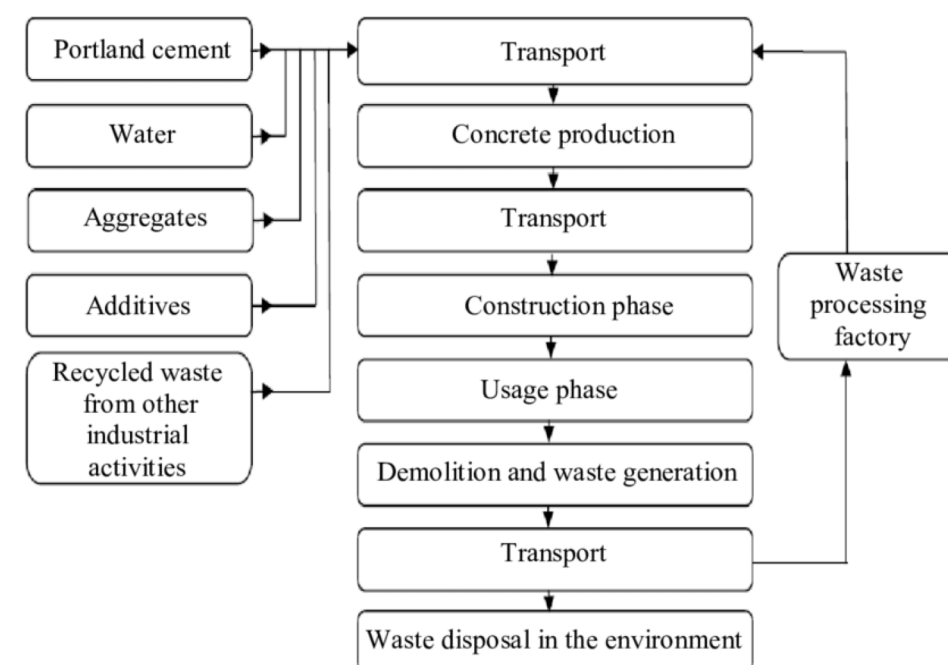
Concrete wagons need to be constantly rotating (Mixing) during transportation to prevent the mix from setting.

A5 - Construction Process

Concrete causes damage to the most fertile layer on earth, the topsoil. Concrete creates hard surfaces which contributes to surface run offs that might cause soil erosion, water pollution and flooding.

On site construction and pouring of concrete uses many machines including concrete pumps, dumper trucks, excavators, concrete poker and finishing tools all producing emissions from diesel fumes running these machines and tools all adding to the LCA of concrete buildings.

Concrete Flow Chart



Use Stage

B

Concrete is a solid material which will last a lifetime without significantly deteriorating. Concrete is able to withstand extreme weathering conditions, chemical spills and abrasions when installed correctly and it is well maintained.

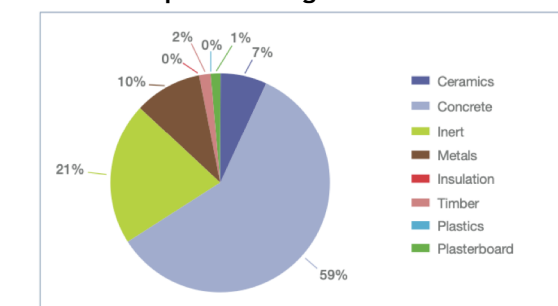
Once the concrete has been installed and hardened there should be very little maintenance required throughout its lifespan unless installed incorrectly.

There is very little inputs and outputs during the lifespan of concrete, most of the emissions and energy used is during the manufacturing period.

End of Life Stage

C

Concrete is part of a Cradle to Grave system meaning from extraction to end disposal. Concrete makes up Roughly 60% of all arisings from demolition works in the UK as per the diagram below.



Dust emissions and fuel consumption is heavily used during the demolition phase.

Modern technologies allow concrete from demolition to be crushed and recycled being re-used as hardcore on construction sites, this is a massive benefit for the environment and a desire to keep construction costs low. Crushing and cleaning concrete aggregate consumes fuel but is more beneficial than having to extract the natural materials from a quarry. Due to the large quantities of recycled concrete Transportation costs are a key player in the overall LCA of concrete buildings.

Conclusion

Since the early 1750s Raw materials have been exclusively used burning the natural materials to create energy and giving outputs of various emissions. Research has warned the amount of Raw materials left on the planet is reducing drastically as our population and modern technologies are growing.

Concrete mostly being made of natural resources is likely to run out one day as global greenhouse gases and emissions are increasing. Environmental LCA is a valuable tool in regards to assessing the impacts of using a product for a building. It is important to look past just the installation environmental factors and assess the Cradle to Grave of the products and systems used.

The whole process of Extracting, crushing, and grinding of natural aggregates produces a greater environmental burden than the processes of crushing and recycling of demolished concrete, especially concerning CO2.

LCA provides a scientific analysis to evaluating the processes, inputs and outputs of concrete comparing it to other structural building products such as timber and steel and ways up the benefits and cons to the material. Concrete building systems combined with insulation have greater benefits than steel frame construction and offers significant energy savings and carbon emissions for the whole life cycle.

Concrete also offers a benefit as it has great thermal mass properties and low air filtration reducing the operational costs and environmental impacts during its usage.

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Product Stage

A1-A3

A1 - Supply of raw materials

The Raw materials extracted in the process of making concrete include:

SAND

Sand aggregates extracted from marine need to be thoroughly washed to remove the salt content. The UK output of sand in 2018 was circa 5Million tonnes. This product is extracted via plant, leading to fuel consumption and emissions.

Cement

The main components in cement are limestone and clay. Limestone and clay are typically dried in a kiln at a temperature of 1450 Degrees Celsius.

There is many processes including extraction, transport and production to make cement.

Aggregates

Aggregates referring to fine gravel and crushed rocks combine to mix throughout the concrete paste acting like a glue between the aggregates. Recycled stone from demolished buildings is usually used within the concrete mix to reduce extract costs. Dust and machine emissions.

A2 - Transport

These, along with few other materials require extraction, preparation and processing before transportation via lorries to a concrete production plant. This process adds to the LCA of the product. Vehicle Pollution. Noise.

A3 - Production

The production of concrete starts with cement production.

Limestone and clay are processed using electricity energy and fuel consumption to crush, mix and heat the materials to create cement powder.

The production of cement releases 4-5% of world CO2 emissions. (Greenspec, 2019)

