BYG515 Specialisation Project

Tittle:

The use of carbon in concrete to reduce CO_2 emissions

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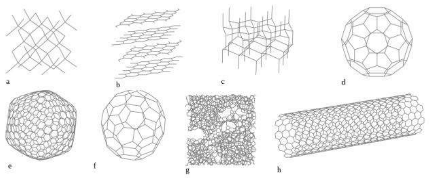
Introduction

Concrete is the most used construction material in the world and is also associated with a large portion of our greenhouse gas emissions. Carbon is a widely found element, as it is present in several million compounds. Human-induced CO_2 emissions affect the climate and well-being of people around the world and give an imbalance in the natural level of carbon in the atmosphere. To investigate the possibilities of reducing CO_2 emissions from concrete, this specialization project studies the environmental implications of applying carbon in concrete. The foundation for this study will comprise a comprehensive literature review to investigate the research question: *How can carbon be used to reduce CO_2 emissions from concrete?*



Different forms of carbon

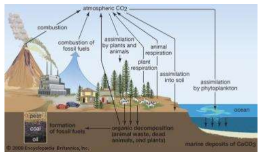
Social perspective

Today's economy, linear economy, is based on extraction, production and use, and incineration or disposal of waste. Due to growing demand and our traditional ways natural resources are under increased pressure. Great focus is placed on how we cultivate our raw materials, and new economic perspectives are developed. Circular economy is often referred to as the opposite of linear economy, where natural resources and products already in system are efficiently used for the longest extent of time possible.

Theory

Water, materials, and energy are natural resources that the construction industry uses to a large extent. Consequently, the industry is closely connected to global and local challenges related to climate change, human health, and the daily life of society. Furthermore, given that carbon is a widely available substance, utilising by-product carbon substances in concrete can support the sustainability of concrete production and its use in the construction industry.

The Norwegian standard for concrete NS-EN 206 defines concrete as a "*material formed by mixing cement, coarse and fine aggregate and water, with or without the incorporation of admixture, additions of fibres, which develops its properties by hydration*". Carbon is a non-metallic chemical element with four valence electrons which can partake in bonding to other carbons and elements.



The generalised carbon cycle

The carbon cycle is the constant flow of all available carbon through nature. It is the process of organisms taking and using before rendering carbon back to the environment. It is well known that the main environmental implications from concrete originate from the production process of cement. About 60% of the CO_2 emissions comes from the calcination process.

Research Question

How can carbon be used to reduce CO_2 emissions from concrete?

- *In what form is carbon used today?*
- *What is the potential for reduction?*

Method of Analysis

A narrative literature review was chosen to ensure a broad understanding and overview of the topic. This theoretical approach gives perspective of the subject studied together with a summation of the available knowledge. A common disadvantage of a narrative literature review is when studying relevant literature, contradicting litterateur is ignored. This results in obtained literature that only shows evidence of support and does not undermine the research in question.

Results

The literature review showed that there were many experiments with concrete containing carbon. The different carbon solutions reviewed are:

- Carbon infused concrete
- Speeding up carbonation curing
- Biochar
- Activated carbon
- Recycled nano carbon black
- Graphene
- Carbon fibres

Discussion

The material properties of concrete containing carbon give different results depending on the shape of the carbon. Infusing concrete with carbon for curing could be a way of saving the amount of drinking water used by the concrete industry today. Biochar is not likely to be added in concrete to increase compressive strength, but it will store the carbon, so it is not released back into the carbon cycle. Locking carbon into concrete reduced the carbon that is in circulation, and since many of the products used are waste, this is a way to decrease CO_2 emissions from the concrete industry. Using by-products can be a way of increasing the sustainability and give a positive influence on the economy for the industries where for example biomass is a waste product as it at the same time is a resource for the concrete producers.

Conclusion

Concrete can take up CO_2 by natural carbonation, which can be accelerated by chemical addition. Carbonaceous materials can be mixed into the concrete. Carbon fibre in various forms is used in concrete today. Experiments have been done with biochar, graphene and carbon black. Regulations and standards can delay or stop the advances related to the use of carbon in concrete. As CO_2 storage, concrete has excellent potentials for atmospheric CO_2 reduction. If the various carbon solutions are adapted in an appropriate manner, technical and environmental benefits can be obtained. A reduction in the carbon footprint of concrete will help alleviate the negative environmental concerns related to the concrete industry today.