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Recycled concrete aggregates from construction and demolition waste in India - CO_2 binding by carbonation

Statement of the Problem: Construction and Demolition waste (C&D waste) is one of the biggest waste streams in most countries. The heavy inorganic part (from concrete and masonry) could be processed and refined into recycled aggregates. This type of aggregates could substitute natural aggregates in a range of user applications like road construction, landscaping and concrete production. This will save natural resources, decrease transportation, reduce landfilling and bind CO_2 through increased carbonation. The purpose of the study is to calculate the binding potential in the Indian concrete.

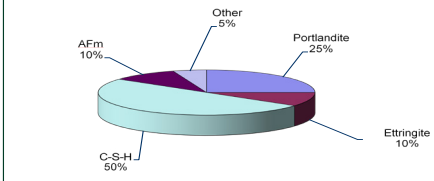

Figure 1: The calcium in the cement hydrate phases reacts with dissolved CO_2 from the air to form stable $CaCO_3$. AFm; monosubstituted aluminoferrite C-S-H; calcium silicate hydrate.

Methodology & Theoretical Orientation: Carbonation of concrete normally occurs when air or water-borne CO_2 dissolves in the concrete pore water and react with Ca^{2+} to form stable $CaCO_3$. Upon carbonation, the pH of the concrete pore water is decreased to around 9. Carbonation mainly involves decalcification of the Ca-bearing hydrate phases when different polymorphs of $CaCO_3$ are formed. In addition, the Mg-bearing hydrate phases (OH-hydrotalcite and CO_3-hydrotalcite) will also carbonate by forming $MgCO_3$ and $Al(OH)_3$.

Findings: Applying the cement chemistry of the hydrate phases, a realistic binding of 200 kg CO_2/ton cement has been calculated for Indian concrete. It has been assumed an average clinker factor of 0.75. Furthermore, accounting for a total annual Indian cement consumption of 300 million tons, the emission during cement production is 180 million tons, i.e. 600 kg CO_2/ton cement. Due to carbonation, 10-20% of the emission are re-absorbed in service life, i.e. the remaining binding potential is around 18-36 million tons. If 10% of the cement consumed in concrete is recycled, minimum 5 million tons of CO_2 may potentially be bound due to the recycling.

Conclusion & Significance: The binding of CO_2 to concrete materials due to carbonation is significant. The CO_2 binding potential can be further utilized by recycling of C&D waste.

Recent Publications

1. Engelsen C J, Van Der Sloot H A, Petkovic G (2017) Long-term leaching from recycled concrete aggregates applied as sub-base material in road construction. *Science of the Total Environment*; 587-588.

Biography

Christian J Engelsen is a Senior Scientist at SINTEF. His research field of interest is in processing and treatment of various waste types, integration of mineral waste into cementitious systems, technical and environmental performance. He is a Specialist in metal and CO_2 binding mechanisms to cementitious systems and materials effect on drinking water. He has 20 years of experience with treatment and recycling of construction and demolition waste and is currently leading an Indo-Norwegian institutional cooperation between Central Public Works Department (Ministry of Housing and Urban Affairs) and SINTEF. He has published more than 90 scientific papers in journals, book chapters, conference proceedings and technical reports. He has managed or has been key scientific personnel in more than 150 contract research projects.

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