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Carbonation and CO_2 uptake in concrete

National foreword

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Carbonation and CO_2 uptake in concrete

Carbonatation et absorption du CO2 dans le béton

Karbonatisierung und CO2-Aufnahme von Beton

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European foreword

This document (CEN/TR 17310:2019) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by SN.

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1 Scope

This document provides detailed guidance on the carbonation and carbon dioxide (CO_2) uptake in concrete. This guidance is complementary to that provided in EN 16757, *Product Category Rules for concrete and concrete elements*, Annex BB.

Typical CO_2 uptake values for a range of structures exposed to various environmental conditions are presented. These values can be incorporated into EPDs for the whole life cycle for either: a functional unit, one tonne or one m^3 of concrete, without necessarily having any detailed knowledge of the structure to be built.

In the rest of the document, the data will be given per m^3.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Carbonation, the uptake of carbon dioxide

4.1 Compounds, chemistry and notation

4.1.1 Carbon dioxide: Chemically expressed as CO_2 and present in the atmosphere as a gas. When CO_2 is dissolved in water, H_2O, it may form carbonic acid, H_2CO_3, where this may release carbonate, CO_3^{2-}, and bicarbonate, HCO_3^- ions.

4.1.2 Calcium hydroxide: Chemically expressed as $Ca(OH)_2$ and often called Portlandite. It is a product of the hydration of Portland cement and is always present in concrete. For simplicity, cement chemists often denote calcium hydroxide as CH. Calcium hydroxide is not very soluble in water but is does dissolve to the ions Ca_2^+ and $2OH^-$. The presence of calcium hydroxide in concrete is largely responsible for maintaining its alkaline environment, which is at a pH around 12,5. Around 25 % of hardened hydrated cement is $Ca(OH)_2$.

4.1.3 Calcium oxide: Chemically expressed as CaO. Portland cement clinker contains 61 % to 67 % CaO by oxide analysis, and where typically the assumed value is 65 %. Nearly all the calcium oxide in Portland cement is not present as calcium oxide but as part of more complicated compounds such as di-calcium silicates, tri-calcium silicates, tri-calcium aluminate and tetra-calcium alumina ferrite. Fortunately using the oxide analysis figure of 65 % CaO is sufficient for the calculation of potential carbonation without going into the more complex chemistry.

4.1.4 Calcium silicate hydrates, and other hydration products: When Portland cement reacts with water, that is when it hydrates, it forms calcium hydroxide and a larger proportion of complex hydration products where the bulk of these are made up of calcium and silica. The hydration products, or gel as described by concrete technologists, are called calcium-silica-hydrates, often simplified to CSH. For a typical composition of hardened hydrated cement it is assumed 50 % is CSH, around 25 % is calcium hydroxide, 10% calcium monosulfoaluminate-AFm, 10 % ettringite-AFt leaving 5 % undefined.