Carbonation of concrete

FORMTEX®
Controlled Permeability Formwork (CPF) liner

What is carbonation?

Carbonation is the formation of calcium carbonate ($CaCO_3$) by a chemical reaction in the concrete. The creation of calcium carbonate requires three equally important substances: carbon dioxide (CO_2), calcium phases (Ca), and water (H_2O). Carbon dioxide (CO_2) is present in the surrounding air, calcium phases (mainly $Ca(OH)_2$ and CSH) are present in the concrete, and water (H_2O) is present in the pores of the concrete.
The first reaction is in the pores where carbon dioxide (CO_2) and water (H_2O) react to form carbonic acid (H_2CO_3):

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

The carbonic acid then reacts with the calcium phases:

$$H_2CO_3 + Ca(OH)_2 \longrightarrow CaCO_3 + 2{\bullet}H_2O$$

Once the $Ca(OH)_2$ has converted and is missing from the cement paste, hydrated CSH (Calcium Silicate Hydrate - $CaO{\bullet}SiO_2{\bullet}H_2O$) will liberate CaO which will then also carbonate:

$$H_2CO_3 + CaO \longrightarrow CaCO_3 + H_2O$$

When these reactions take place the pH value will start falling. The normal pH-value of concrete is above 13 and the pH-value of fully carbonated concrete is below 9. Once the carbonation process reaches the reinforcement, and the pH-value drops beneath 13 the passivating "film" on the re-bars will deteriorate and corrosion will initiate as described in the flyer "Reinforcement corrosion of concrete".

Speed of carbonation

The speed of the carbonation process through the concrete mainly depends on two parameters:

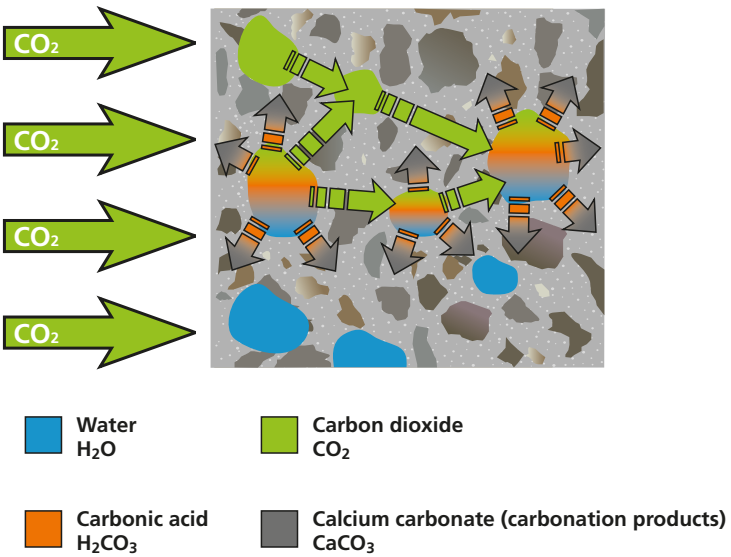
- The porosity of the concrete
- The moisture content of the concrete

The porosity of the concrete

The carbonation process has an ongoing need for carbon dioxide (CO_2) from the atmosphere. For carbonation to spread, fresh carbon dioxide from the surface needs to be supplied continuously deeper and deeper into the concrete. Low porosity and permeability will decrease the ingress speed of carbon dioxide (CO_2) from the atmosphere, thereby delaying the ingress of the carbonation.

Moisture content of the concrete

The moisture content of the concrete is also a very important factor. Carbonation in concrete pores almost only occurs at a relative humidity (RH) between 40% and 90%. When the relative humidity in the pores is higher than 90% carbon dioxide is not able to enter the pore, and when RH is lower than 40% the carbon dioxide can not dissolve in the water.



Fibertex NONWOVENS

Fibertex Nonwovens A/S
Svendborgvej 16
DK-9220 Aalborg
Denmark

Tel. +45 96 35 35 35
Fax +45 98 15 85 55
fibertex@fibertex.com
www.formtex.dk

Version 04/2020