Concrete Carbonation

• Discussion of the behavior of concrete is generally based on the assumption that the ambient medium is air which does not react with hydrated cement paste.
• However, in reality, air contains CO$_2$ which, in the presence of moisture, reacts with hydrated cement.
• The actions of CO$_2$ takes place even at small concentrations such as in rural air, where the CO$_2$ content is about 0.03 percent by volume.
• In large cities the content may rise above 0.3 percent and, exceptionally, up to 1 percent. An example of concrete exposed to a very high concentration of CO$_2$ in the industrial cities
• The rate of carbonation of concrete increases with an increase in the concentration of CO$_2$. What else?
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- The transport of CO$_2$ taking place through the pore system in hardened cement paste (Porosity OR permeability?).
- In the hydrated cement paste CO$_2$ reacts with Ca(OH)$_2$ to product CaCO$_3$.
- Carbonation itself does not cause deterioration of concrete but it has important effects such as:
  - Causing carbonation shrinkage, it would be explained later.
  - Reducing pH of the pore water in hardened Portland cement paste from between 12.6 to 13.5 to a value of about 9. What is its effect on concrete durability?
  - When all Ca(OH)$_2$ has become carbonated, the value of pH is reduced to 8.3.
  - The highest rate of carbonation occurs at a relative humidity of between 50 and 70 percent. WHY?
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- Progress of carbonation with time of exposure under different conditions:
  - 20°C and 65 per cent relative humidity;
  - outdoors, protected by a roof;
  - horizontal surface outdoors.

The values are averages for concretes with water/cement ratios of 0.45, 0.60, and 0.80, wet-cured for 7 days.
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- The effect of curing on carbonation of concrete is substantial.
- The depth of carbonation of concretes with 28-day compressive strength can be showing in figure below.