



Integrated Research Centre (IREC)

Example Manual

Concrete Carbonation – Bob & Afana Model



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Concrete carbonation according to Bob & Afana

1. Introduction

This example estimates the carbonation depth x_c based on the Bob & Afana model [1] for a bridge deck made with OPC concrete of strength class C20/25. The calculation is defined by the influence of cement type ($r_c = 1$ is assumed), relative humidity (partly wet environment is assumed), CO₂ concentration (assumed CO₂ concentration is 0.03% which corresponds to 300 ppm of CO₂ in the atmosphere), and exposure time of 30 years.

2. Input variables

Notation	Variable	Value	Unit
r_c	Coefficient of cement type	1.00	-
$f(RH)$	Coefficient for the effect of ambient relative humidity	0.50	-
r_{CO_2}	Coefficient for CO ₂ concentration	1.00	-
f_c	Compressive strength of concrete	20.00	MPa
t	Time of exposure	30.00	years
θ	Uncertainty factor of model	1.00	-

3. Deterministic Calculation and Comments

Based on the proposed model, the carbonation depth x_c in time t is calculated as:

$$x_c(t) = \theta \cdot 150 \cdot \frac{r_c f(RH) r_{CO_2}}{f_c} \sqrt{t} = 1.00 \cdot 150 \cdot \frac{1.00 \cdot 0.5 \cdot 1.00}{20} \sqrt{30} = 20.54 \text{ mm}$$

Note: The CO₂ concentration can be set in parts per million by volume (ppm) or another unit, e.g. mg/m³. For conversion between these units see the 'C_CO2' sheet in the Excel template file, where the temperature of ambient air in °C is defined as an input parameter and the CO₂ concentration is calculated in mg/m³ for the range of values in ppm.

4. Literature

- [1] Bob, C. & Afana, E. (1993) On-site assessment of concrete carbonation. In Proc. of Int. Conf. Failure of Concrete Structures, Štrbské Pleso, Slovak Republic, 84–87.