CO_2 uptake in Concrete

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Norcem AS

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Plan

- What is carbonation and CO_2 uptake
- Project 'CO_2 opptak i Betong', Environmental committee, Norwegian Concrete Association


Vesentlig klimagass-fangst i norsk betong


BETONG SPISER CO_2

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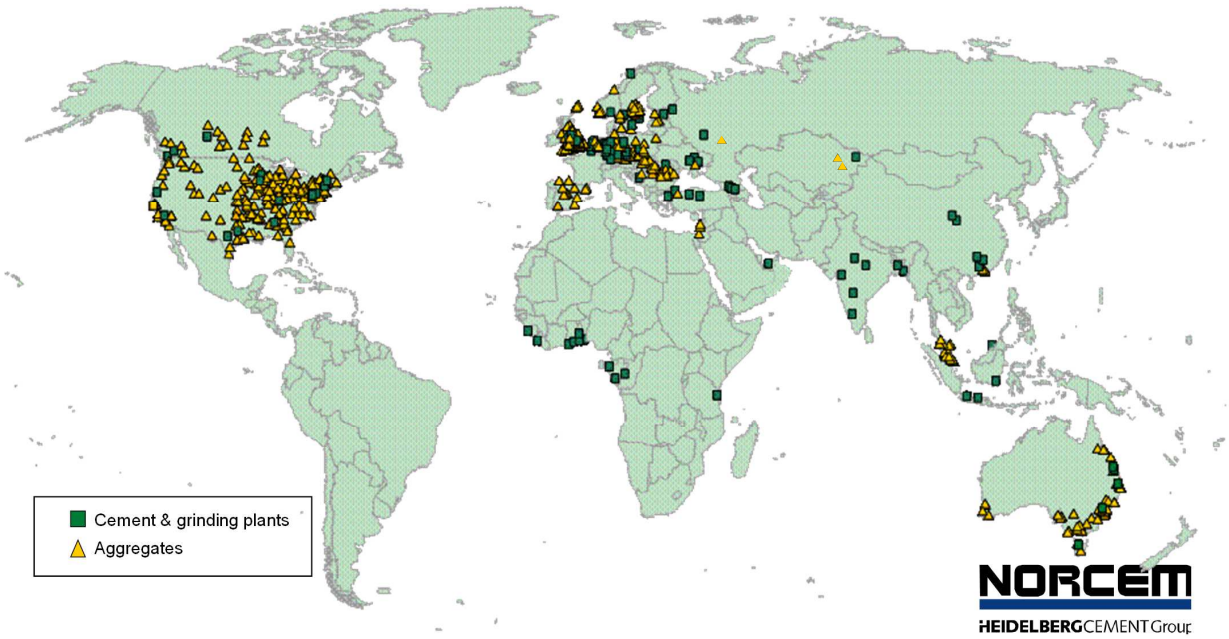
HeidelbergCement in the world

No 1 in aggregates
No 3 in cement
No 2 in ready-mixed concrete
53,000 employees in over 40 countries



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HeidelbergCement in Norway




Cement	Alternative fuel	RM Concrete	Aggregates
Norcem	Renor	NorBetong	NorStone

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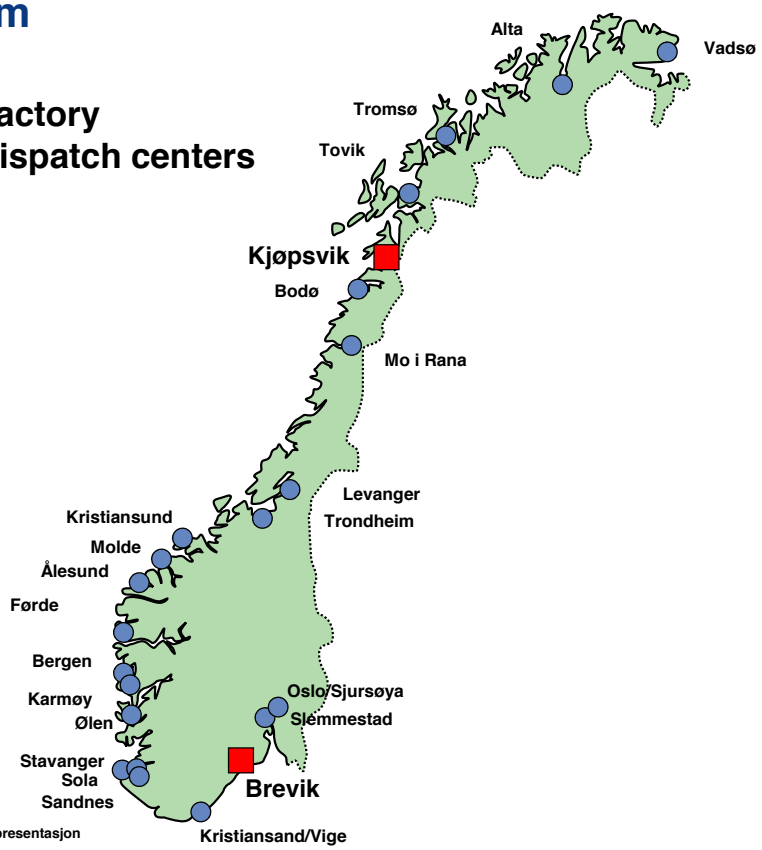
- Factory
- Dispatch centers



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Brevik

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Norcem R&D Department

- **Staff**
  - R&D manager (PhD)
  - 1 senior engineer (BSc)
  - 2 project managers (PhD, MSc)
  - 1 project technician

- **Tasks, responsibilities**
  - Product development
  - Technical customer service
  - R&D project

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CO_2 emission from concrete
Example: 220 kg CO_2/m^3

Cement	**95%**
Other materials	**1,5%**
Transport materials	**2%**
Production	**0,5%**
Transport to customer	**2%**
Sum	**100%** **220 kg CO_2/m^3**


Environmental Declaration ISO 14025
epd-norge.no
Fabrikkbetong
B35M45
NEPD nr: 136N
NORBETONG
HEIDELBERGCEMENT Group
NorBetong - Alnabru
Produktspesifikasjon

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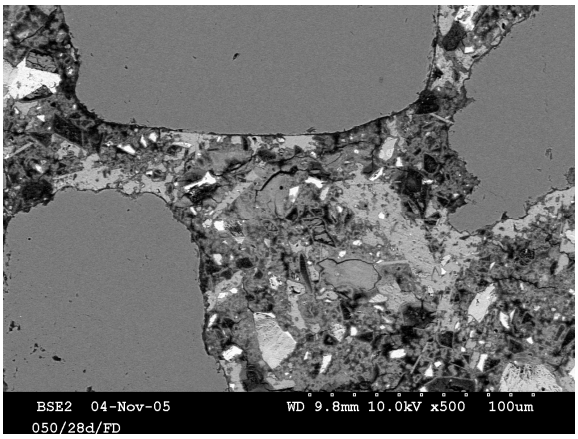
Process of carbonation (CO_2 uptake)

-Aggregates
-Pores, porewater
-C-S-H
-CH
-AF

CO_2 →



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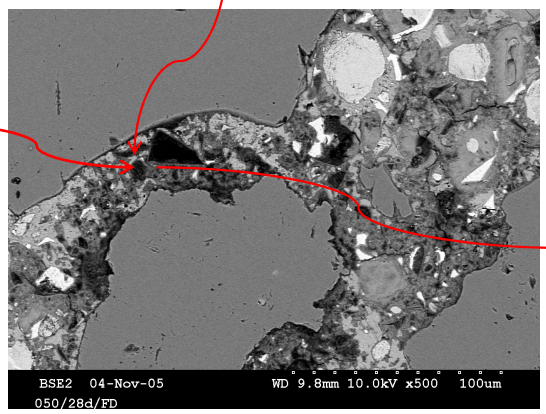
Process of carbonation (CO_2 uptake)

$Ca(OH)_2 \Leftrightarrow Ca^{2+}+2OH^-$

HCO_3^-
CO_3^{2-}



$Ca^{2+} + CO_3^{2-}$
$\Rightarrow CaCO_3$

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CO_2 uptake (bindingcapacity)

): 72% of the total CaO amount in concrete will react with CO_2 upon carbonation

- **CO_2 uptake in concrete with CEM I**
  => 330 kg CO_2/tonn sement (40%)

- **CO_2 emission if concrete with CEM I**
  => 758 kg CO_2/tonn sement

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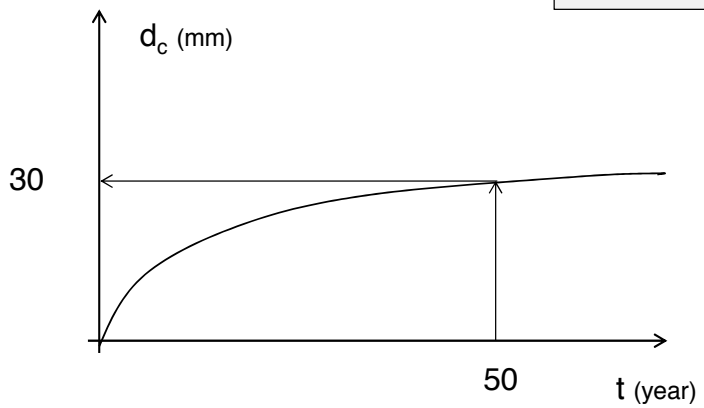
Rate of carbonation

$$d_c = k \times \sqrt{t}$$

dc – carbonation depth
k – 'diffusion coefficient'



Example:
t = 50 years
d_c = 30 mm
=> k = 4,24 mm/√years

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Project: CO_2 uptake in concrete

1: Documentation of CO_2 uptake in the stock of Norwegian concrete structures

- Data 'k' (rate of carbonation factors) and spec. CO_2 uptake during carbonation for Norwegian concrete types and cement products
- CO_2 uptake in the stock of Norwegian concrete structures pr year

2: Consider the possibility of including CO_2 uptake in LCA (Life cycle analyses) and EPDs (Environmental product declarations)

- Consider possibilities/limitations in the Standards of LCA and EPDs
- Examples of EPDs were CO_2 uptake is included (EPDs for concrete roof tiles, hollow core slab, indoor wall of RMC

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Project: CO_2 uptake in concrete Conclusions, prelimenary

- **CO_2 uptake in Norwegian concrete structures is considerable, 15-20% of the annual CO_2 emission**
- **CO_2 uptake can be included in LCA**
- **CO_2 uptake can as per today not be included in EPDs for concrete**
  - PCR for concrete beeing revised in CEN, CO2 uptake will probably be included in the revised version
  - The example EPDs show that the CO_2 uptake is very dependent on the concrete product
- **CO_2 uptake project will be finalized spring 2014**
  - Reports available at www.betong.net

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CO_2 emission from manufacturing of cement

- **Calcining of limestone (ca 60%)**
  - $CaCO_3$ => $CaO + CO_2$
- **Combustion of fuels (ca 40%)**
  - Heating of materials (1450ºC)
  - Calcining

- **=> CO_2 emission ca 758 kg/ton CEM I (Anlegg cement)**
  - 631 kg/ton STD FA cement