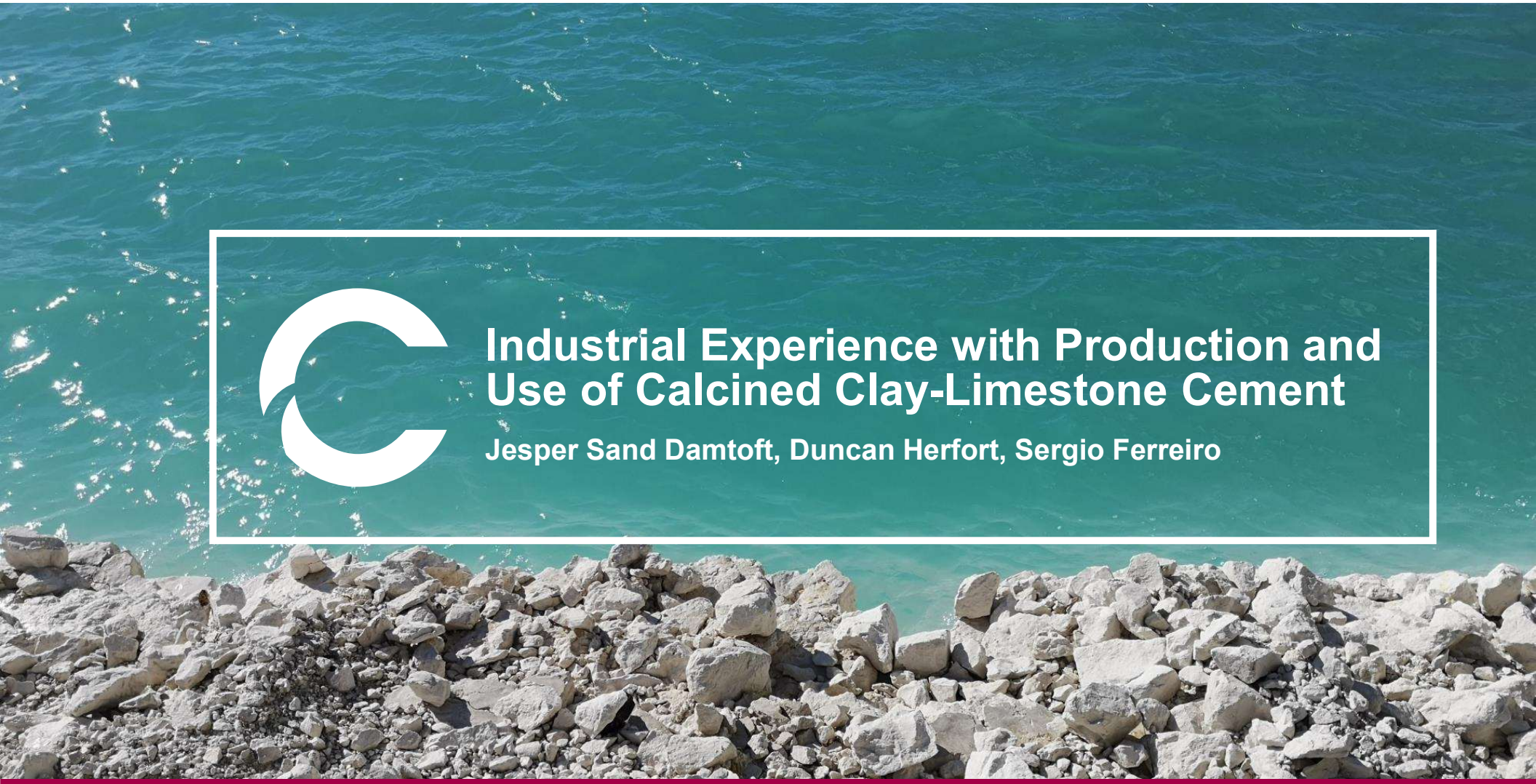

# Industrial Experience with Production and Use of Calcined Clay-Limestone Cement

Jesper Sand Damtoft, Duncan Herfort, Sergio Ferreiro

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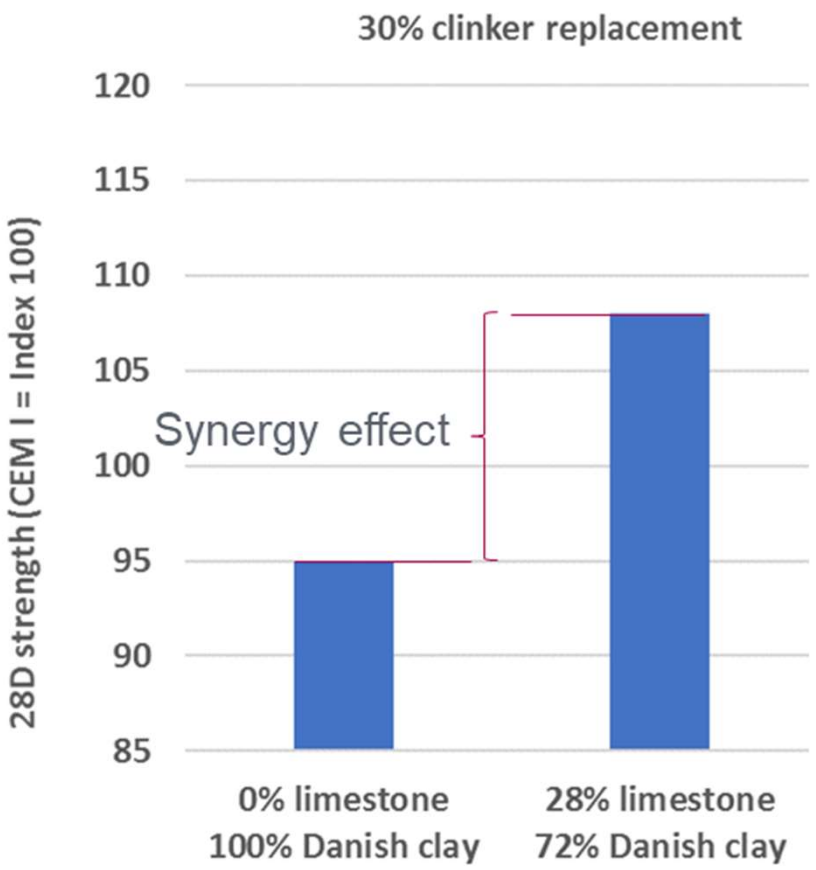
CALTAGIRONE GROUP

Concretely Dynamic

# What is FUTURECEM?

FUTURECEM

- **FUTURECEM** is a robust, **patented** technology which enables production of durable concrete with reduced clinker content compared to conventional concrete.
- Based on the fact that a mixture of **fine-grained limestone** and **calcined clay** develops higher strength when mixed with Portland clinker than expected by blending the two components




**Calcined clay**

Burned at much lower temperature than clinker and small process emissions

**Limestone**

# Cement development at Aalborg Portland

1990-1991: **Synergy effect** discovered by Aalborg Portland

- Objective was to develop a cheap high-strength cement

2008-2011: **FUTURECEM** Project

- The basic technology was documented and further developed.
- Patent application was submitted.

2011-2014: **SCM** Project

- Development of production equipment together with FLSmidth.

2014-2019: **Green Concrete II** Project

- Durability testing and testing in full-scale RMC constructions.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Innovation Fund Denmark

# Green Concrete II

**Green Transformation of Cement and Concrete Production**

- Budget: $ 4.5 million, 50% funded by Innovation Fund Denmark
- Duration: 2014-2019
- Partners from the entire value chain of construction

**Cement producer**
- Aalborg Portland A/S

**Concrete producers**
- Unicon A/S
- Dansk Beton Fabriksbetongruppen

**Contractor**
- MT Højgaard A/S

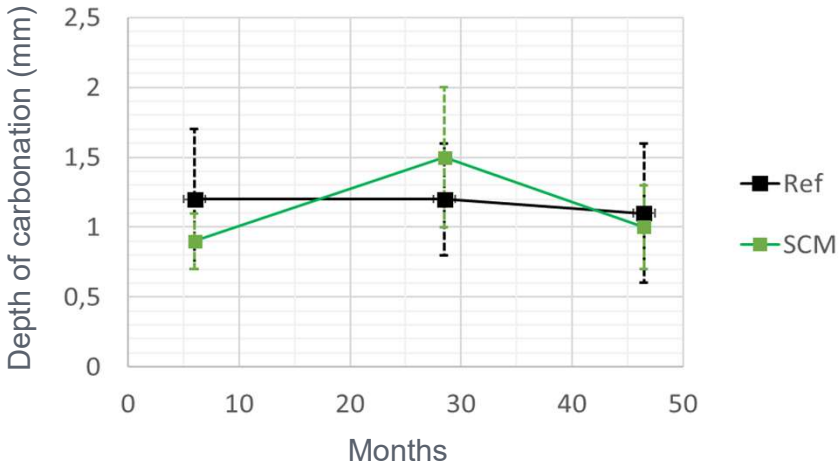
**Consulting Engineers**
- Sweco
- Rambøll Danmark A/S

**Knowledge institutions**
- Danish Technical University
- Danish Technological Institute
- Four schools and colleges

**Public building owners**
- Danish Road Directorate
- Danish Rail Authority
- Femern Link

# Durability tested in laboratory and full scale

FUTURECEM

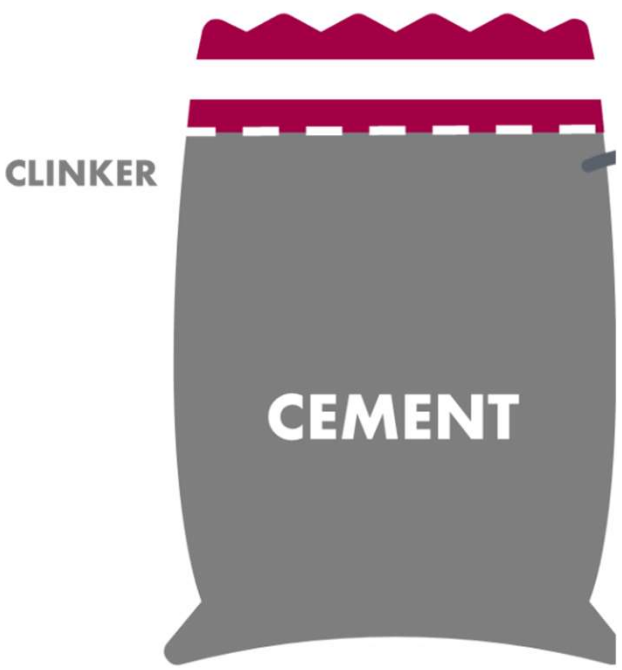
# Demo structures: Part of bridges and and indoor construction

FUTURECEM


**FUTURECEM is a cement based on natural SCM, therefore no need for industrial residues, such as fly ash or slag**

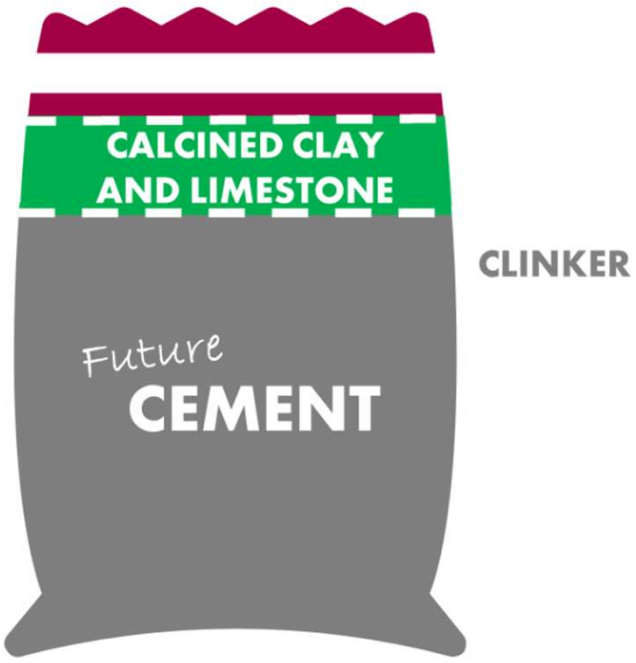
FUTURECEM

Ordinary Portland Cement



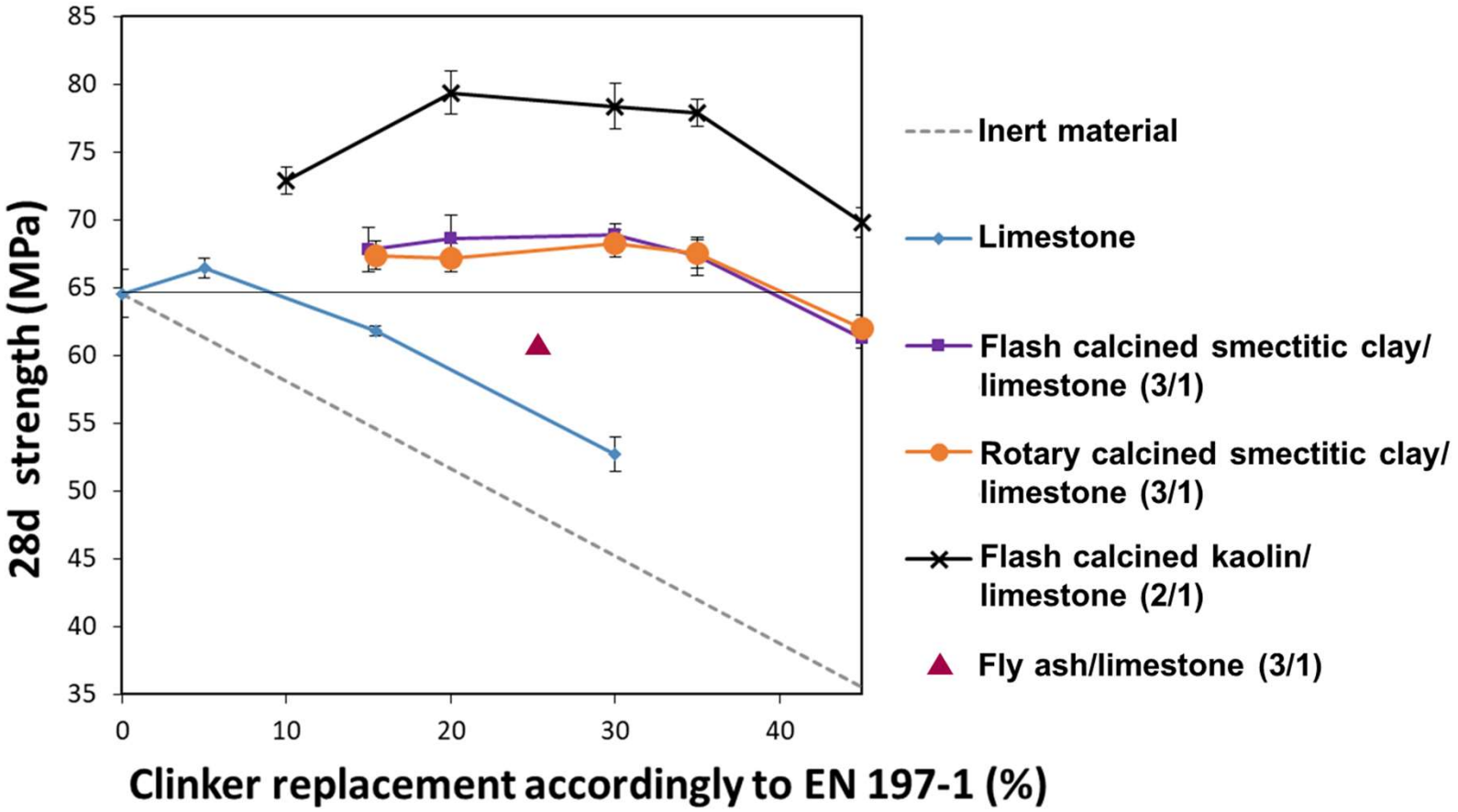



FUTURECEM



## Calcined clay can be produced by rotary kilns or flash calciners

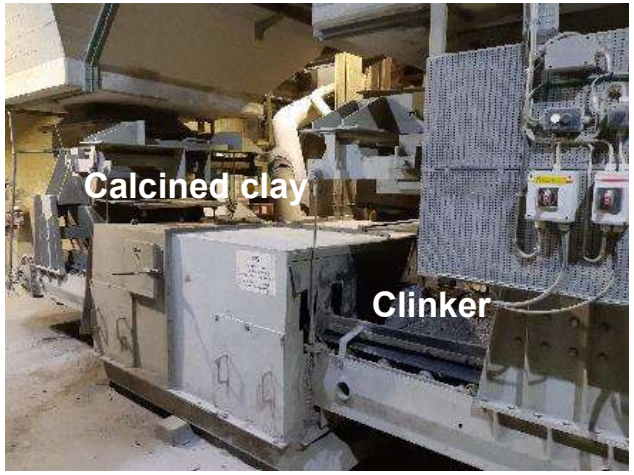
FUTURECEM

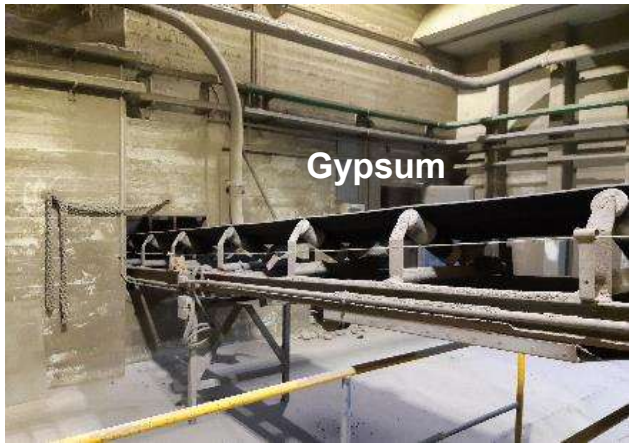


# Full-scale production of FUTURECEM™

FUTURECEM

Calcined clay as received




# Introduced in the market on January 1, 2021

FUTURECEM


DS

DS/EN 206 DK NA:2020

2020-[illegible]

Beton – Specifikation, egenskaber, produktion og overensstemmelse – Regler for anvendelse af EN 206 i Danmark

Concrete – Specification, performance, production and conformity – Rules for application of EN 206 in Denmark

DANSK STANDARD

Acceptance in the National Application Document of the European Concrete Standard

Certificate of consistency of performance

Compliance with the cement standard:

EN 197-1:2011


| | OPC | FUTURECEM™ |
|---|---|---|
| **Type (EN 197-1)** | CEM I 52.5N | CEM II/B-M (Q-LL) 52.5N |
| **1 day strength** (MPa) | 21-25 | 13-19 |
| **2 day strength** (MPa) | 34-38 | 25-33 |
| **28 day strength** (MPa) | 64-70 | 61-69 |
| **Density** (kg/m$^3$) | 3140 | 3020 |
| **$Na_2O_{eq}$** (%) | 0.5-0.64 | 0.6 |

# Large project - UN 17 Village

FUTURECEM

- 17 UN Sustainable Development Goals
- Housing project in Ørestad
- Building owner: NREP
- Contractor: C.G. Jensen A/S
- Ready-mix concrete: Unicon A/S
- 10.000 $m^3$ ready-mix concrete with FUTURECEM$^{TM}$

Visualisering: TMRW

Fotos: Unicon

unicon
CEMENTIR HOLDING

# Environmental impact

FUTURECEM

## Global Warming Potential

**599**

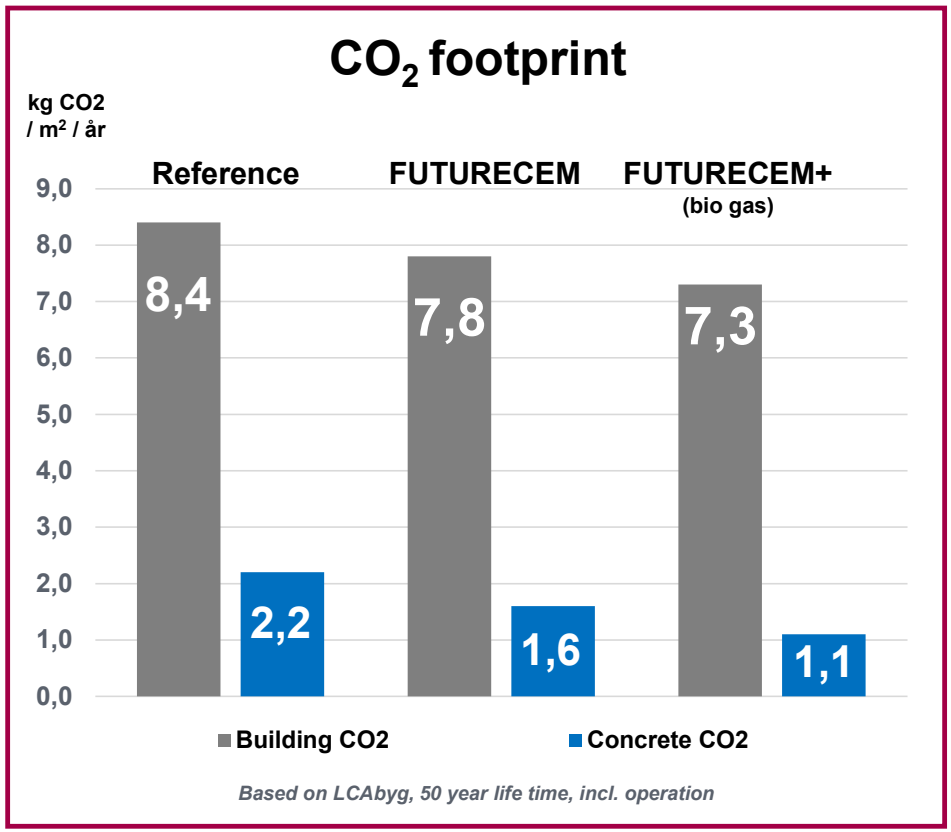
**kg $CO_2$ pr. ton**

**Cradle to gate:**

- ✓ Raw materialer
- ✓ Transport
- ✓ Production

**599 Kg $CO_2$-eqv**

# $CO_2$ case: Apartment building





Total $CO_2$ reduction in building

**-591000 KG**

| Concrete $CO_2$ footprint | Building $CO_2$ footprint |
|---|---|
| **-27%** | **-7%** pr m2 |

## CALLISTE:
## CALcined clay LImeStone cement Technology Extension

FUTURECEM

### Objectives

- Increase early strength, targeting pre-cast and dry-cast concrete.
- Develop FUTURECEM with up to 50% clinker substitution as allowed in the new EN 197-5
- Develop approval criteria for cements with extreme clinker substitutions,
- Develop best practice guidelines for mix design and production of concrete using FUTURECEM with extreme clinker substitution

### Budget

- Budget: $ 5.3 million
- Investment by Innovation Fund Denmark: $ 3.3 million
- Duration: 4 years, 1 month, start October 2020

**12 partners representing academia, industry and final users**

**Jesper Sand Damtoft**
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