



**27/11/2025 plkst. 9:00**

Rīga Islande Hotel



Latvijas  
Betona  
Savienība

# **BETONA KONSTRUKCIJAS AR SAMAZINĀTU VIDES NOSPIEDUMU**

Latvijas Betona savienības

**33. zinātniski tehniskā konference**

Dr.ing, asoc. prof. Rolands Cepurītis  
Latvijas Betona savienības valdes priekšsēdētājs

2025. gada 27. novembrī  
Rīga

KONFERENCI  
BETONA KONSTRUKCIJAS AR  
SAMAZINĀTU VIDES NOSPIEDUMU  
RĪKO



Latvijas  
Betona  
Savienība

KONFERENCES LIELDRAUGI



**MB** GRUPA

**SAFE** GROUP  
BETONA KONSTRUKCIJAS

KONFERENCES PARTNERI



KONFERENCES ATBALSTĪTĀJI



Rigensi

**semtu**



# BETONA OLIMPIĀDE 2025

Jauns nolikums

## Kategorija "Betons"

Mērķis – izgatavot betona paraugus, kas pēc stiprības vistuvāk un visprecīzāk atbilst mērķa stiprībai 85 MPa

## Kategorija "Vieglbetons"

Mērķis – sasniegt augstāku spiedes stiprību vieglbetonam, kura sausā stāvokļa blīvums nepārsniedz 2000 kg/m<sup>3</sup>

Sadarbībā ar



Latvijas  
Betona  
Savienība



Katrā kategorijā

## Naudas balvas



1000 eiro



800 eiro



600 eiro

*Naudas balvas nodrošina  
Stachema Polska Sp. z o.o.*





## TK04 BETONA ILGTSPĒJA

Latvijas Betona savienības  
tehniskās vadlīnijas Nr. 1

Betona CO<sub>2</sub> nospieduma  
klasifikācija



Tehniskās vadlīnijas pieejamas





# BETONA KONSTRUKCIJAS AR SAMAZINĀTU VIDES NOSPIEDUMU

Latvijas Betona savienības  
33. zinātniski tehniskās  
**konferences programma**



**18:45**  **Tīklošanās & kafijas pauze**  
**Networking & Coffee Break**

# PRAKTISKĀ INFORMĀCIJA



Reģistrācijas zonā **pieejamas austiņas tulkojumam** no angļu uz latviešu valodu



Pirms došanās prom reģistrācijas zonā **atgriezt austiņas un vārdu kartes**



Visas konferences garumā dalībnieki **varēs uzdot jautājumus ekspertiem**

Lai uzdotu jautājumu,  
noskenē







# BETONA KONSTRUKCIJAS AR SAMAZINĀTU VIDES NOSPIEDUMU

Latvijas Betona savienības  
**33. zinātniski tehniskā konference**



Latvijas  
Betona  
Savienība

## PALDIES PAR UZMANĪBU!

# KAS IR KLIMATNEITRĀLS BETONS UN KĀ TO ATPAZĪT?

Dr. inž. Artūrs Lukašenoks  
MB Betons, Tehniskais Direktors





# KAS IR KLIMATNEITRĀLS BETONS UN KĀ TO ATPAZĪT?

Dr. inž. Artūrs Lukašenoks  
MB Betons, Tehniskais Direktors

# Klimatneitrāls betons

Betons, kura visa dzīves cikla radītās siltumnīcefekta gāzu emisijas:

- **maksimāli samazinātas**
- **neizbēgamā atlikusī emisiju daļa ir kompensēta** ar zinātniski pamatotām un pārbaudāmām metodēm

Klimatneitrāls betons ir **mērāms, pierādāms** un **izsekojams**

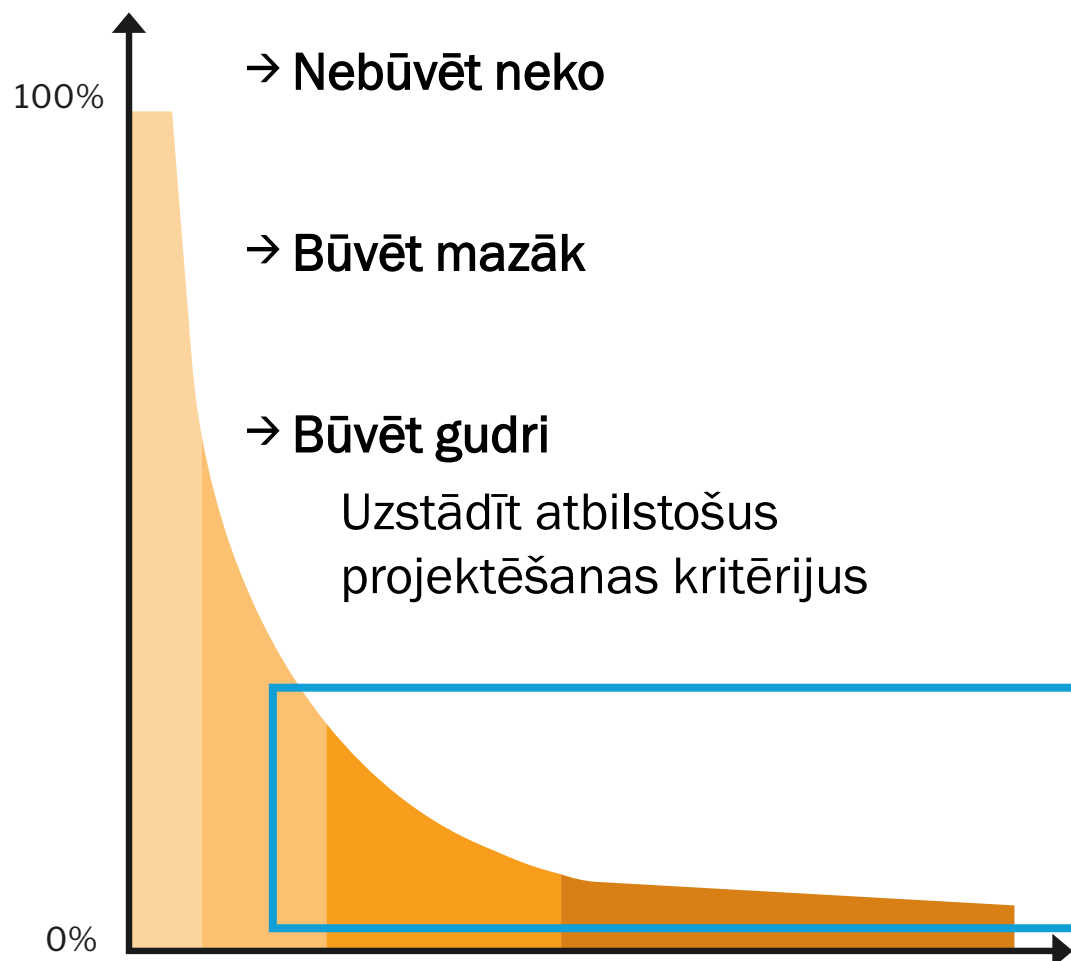
Tas saglabā tādas pašas vai augstākas tehniskās un ekspluatācijas īpašības kā tradicionālais betons.







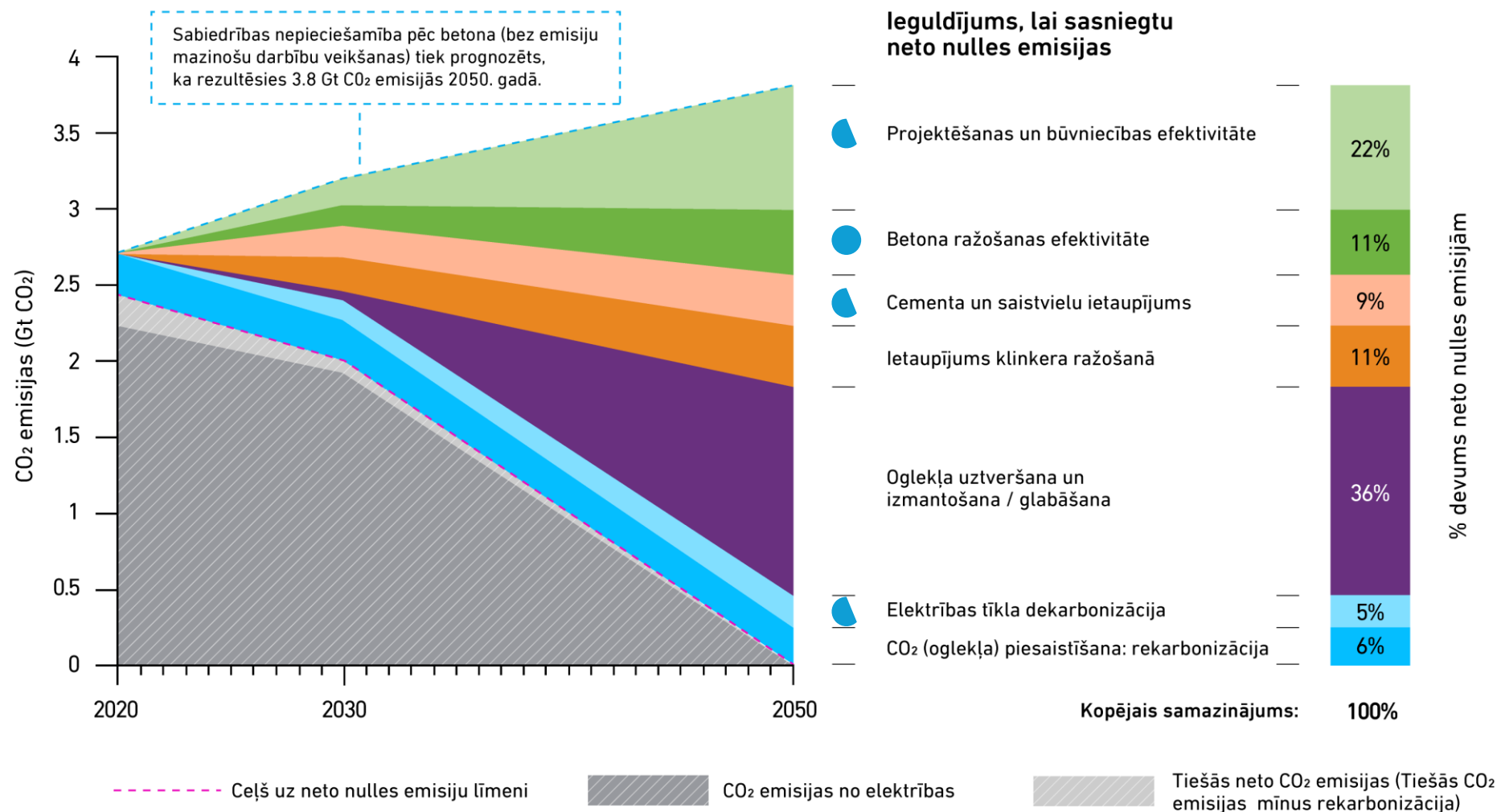
# Emisiju samazināšanas potenciāls



- **Būvēt efektīvi**  
Utilizēt konstrukcijas, atkārtoti izmantot materiālus, izvēlēties oglekļa ziņā efektīvus materiālus un produktus
- **Samazināt zudumus**  
Saliekamā dzelzsbetona produkti, būvniecība ārpus būvlaukuma un jaunas metodes

# NET ZERO CEĻA KARTE

Avots: Global Cement and Concrete Association



# CO2 SAMAZINĀJUMA METODES

- **Betona maisījums**
- Saistvielu uzlabojumi
- Ražošana un produktu izmantošana
- Produktu un risinājumu izstrāde
- Loģistika

| Metode                          | Efektivitāte | Izmaksas | Ilgtermiņa potenciāls |
|---------------------------------|--------------|----------|-----------------------|
| Pārstrādāti inertie materiāli   | Zema         | Zemas    | Augsta                |
| Pārstrādāts ūdens               | Zema         | Zemas    | Augsta                |
| Betona sastāva optimizācija     | Zema         | Zemas    | Augsta                |
| Klinkera ražošanas efektivitāte | Zema         | Vidējas  | Augsta                |
| Oglekļa uztveršana              | Augsta       | Augstas  | Augsta                |



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| Iespēja                              | Efektivitāte | Izmaksas | Ilgtermiņa potenciāls |
|--------------------------------------|--------------|----------|-----------------------|
| Ogļu izdedžu pelnu putekļi           | Vidēja       | Zemas    | Zema                  |
| Malti, granulēti domnas sārņi (GGBS) | Augsta       | Vidējas  | Augsta                |
| Mikrosilika                          | Zema         | Augstas  | Vidēja                |
| Metakaolīns                          | Vidēja       | Augstas  | Vidēja                |
| Kaļķakmens                           | Vidēja       | Zemas    | Zema                  |
| Slānekļa pelni                       | Vidēja       | Zemas    | Zema                  |

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| Iespēja                                 | Efektivitāte | Izmaksas | Ilgtermiņa potenciāls |
|-----------------------------------------|--------------|----------|-----------------------|
| Ražošanas zudumu samazināšana           | Zema         | Zemas    | Augsta                |
| Oglekļa iesaiste svaigā betonā          | Zema         | Vidējas  | Augsta                |
| Svaiga betona cietēšana CO2 kamerā      | Zema         | -        | Zema                  |
| Svaiga betona cietināšana tvaika kamerā | Zema         | -        | Vidēja                |
| Apsildāmi veidņi                        | Zema         | Zemas    | Augsta                |

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- Ražošana un produktu izmantošana
- **Produktu un risinājumu izstrāde**
- Loģistika

| Iespēja                                                         | Efektivitāte | Izmaksas | Ilgtermiņa potenciāls |
|-----------------------------------------------------------------|--------------|----------|-----------------------|
| Pārspīlētu betona prasību mazināšana                            | Zema         | Zemas    | Vidēja                |
| Enerģijas patēriņa samazināšana                                 | Zema         | Zemas    | Vidēja                |
| Pārprodukcijas samazināšana                                     | Zema         | Zemas    | Augsta                |
| Neatbilstošas kvalitātes samazināšana                           | Zema         | Zemas    | Augsta                |
| Būvniecība ārpus būvlaukuma                                     | Vidēja       | Zemas    | Augsta                |
| Atkārtota materiālu un konstrukciju izmantošana un projektēšana | Augsta       | Zemas    | Augsta                |
| Materiālu alternatīvas                                          | Vidēja       | Augstas  | Vidēja                |
| Betona apjoma samazināšana                                      | Vidēja       | Vidējas  | Augsta                |

# CO2 SAMAZINĀJUMA METODEDES

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- **Loģistika**

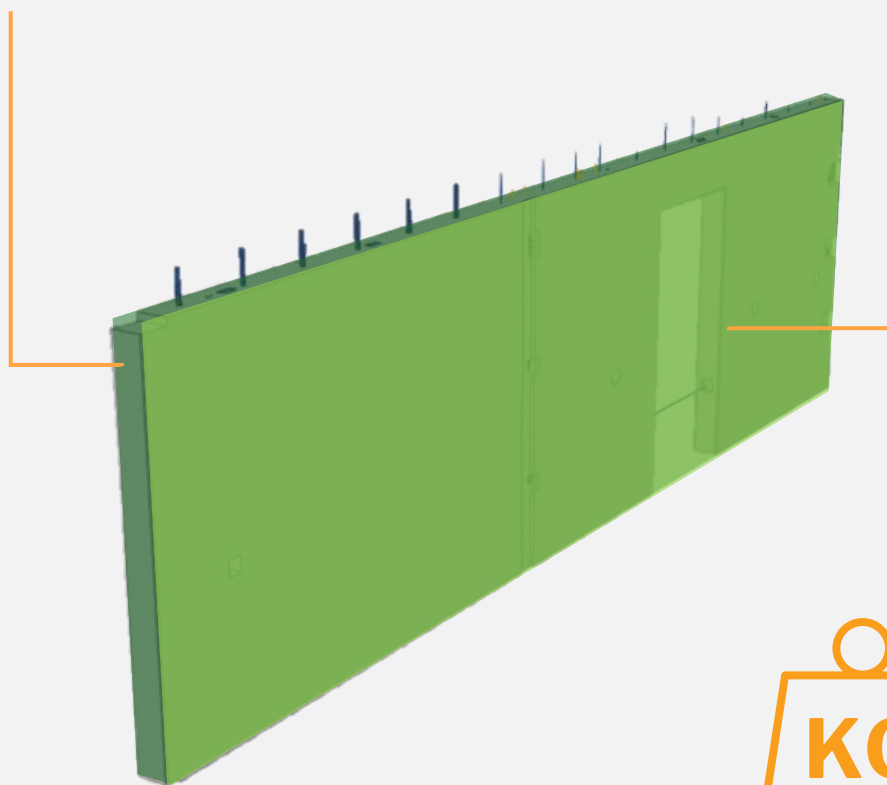
| Iespēja                | Efektivitāte | Izmaksas | Ilgtermiņa potenciāls |
|------------------------|--------------|----------|-----------------------|
| Ūdeņradis              | Augsta       | Augstas  | Augsta                |
| Elektrība              | Augsta       | Vidējas  | Augsta                |
| Biodegviela            | Augsta       | Zemas    | Vidēja                |
| Sašķidrinātā dabasgāze | Zema         | Zemas    | Vidēja                |
| Hibrīds                | Vidēja       | Zemas    | Vidēja                |



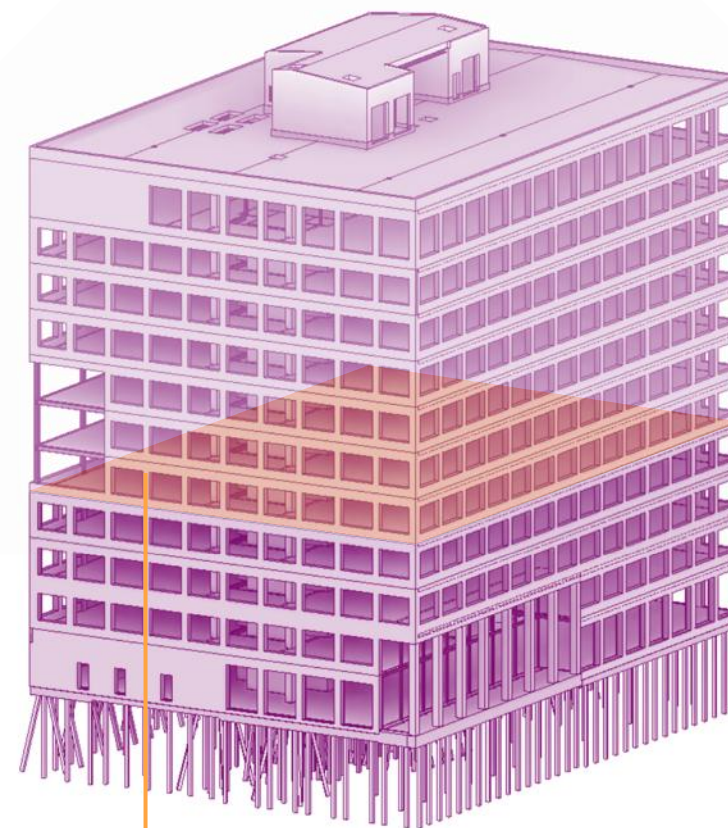
# CO2 mērvienības

313 KG/M3

62 KG/M2



130 KG/T



107 KG/BTA

# Vides produktA deklarācijas saturs



## ENVIRONMENTAL IMPACT DATA

NOTE : ENVIRONMENTAL IMPACTS - EN 15804+A1, CML / ISO 21930 AND ENVIRONMENTAL IMPACTS – TRACI 2.1./ ISO 21930 ARE PRESENTED IN ANNEX.

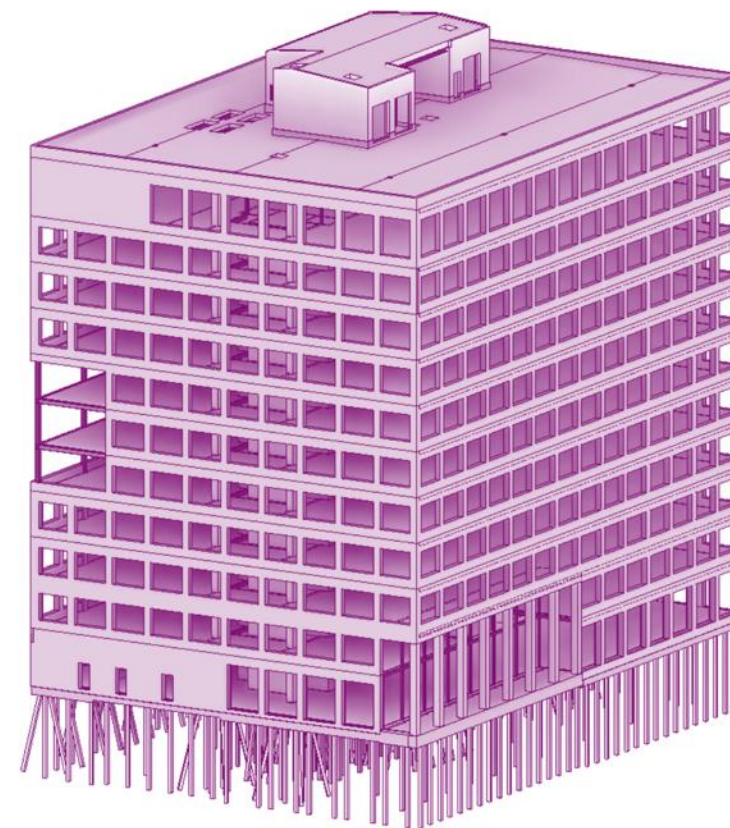
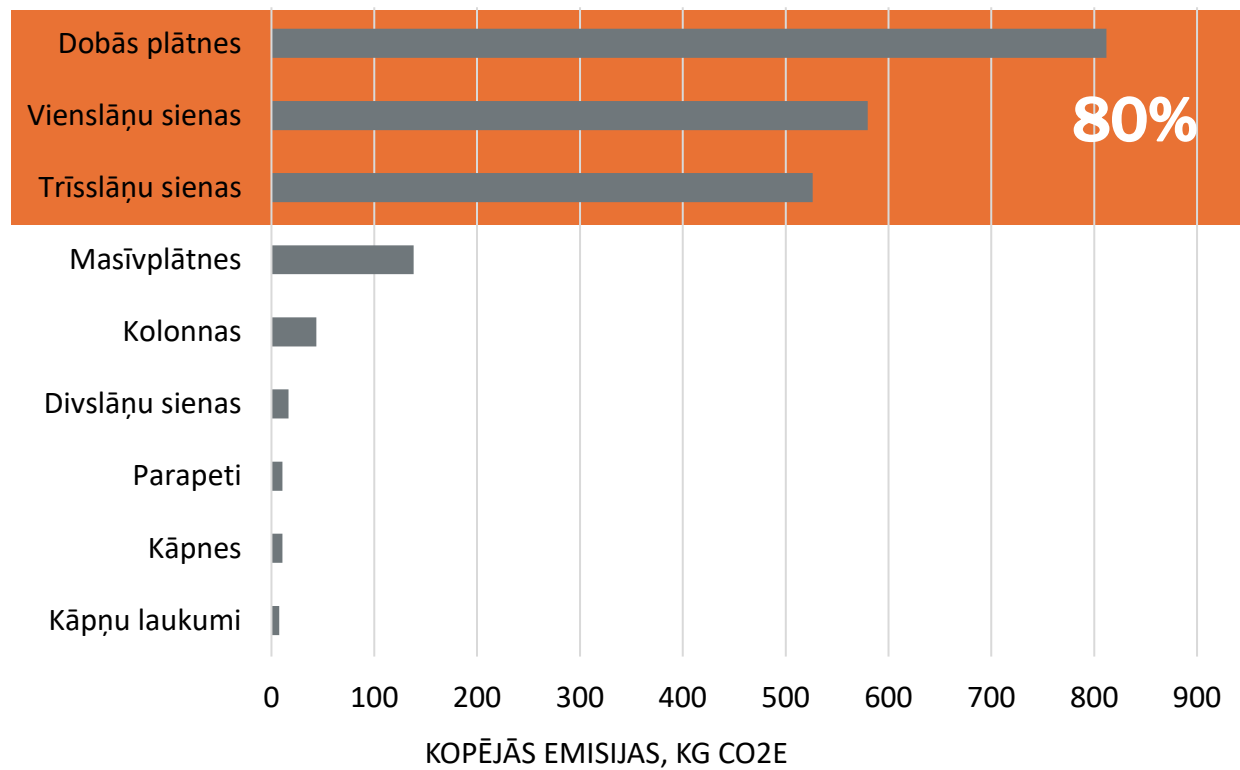
### ONE LAYER WALLS

#### CORE ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, PEF

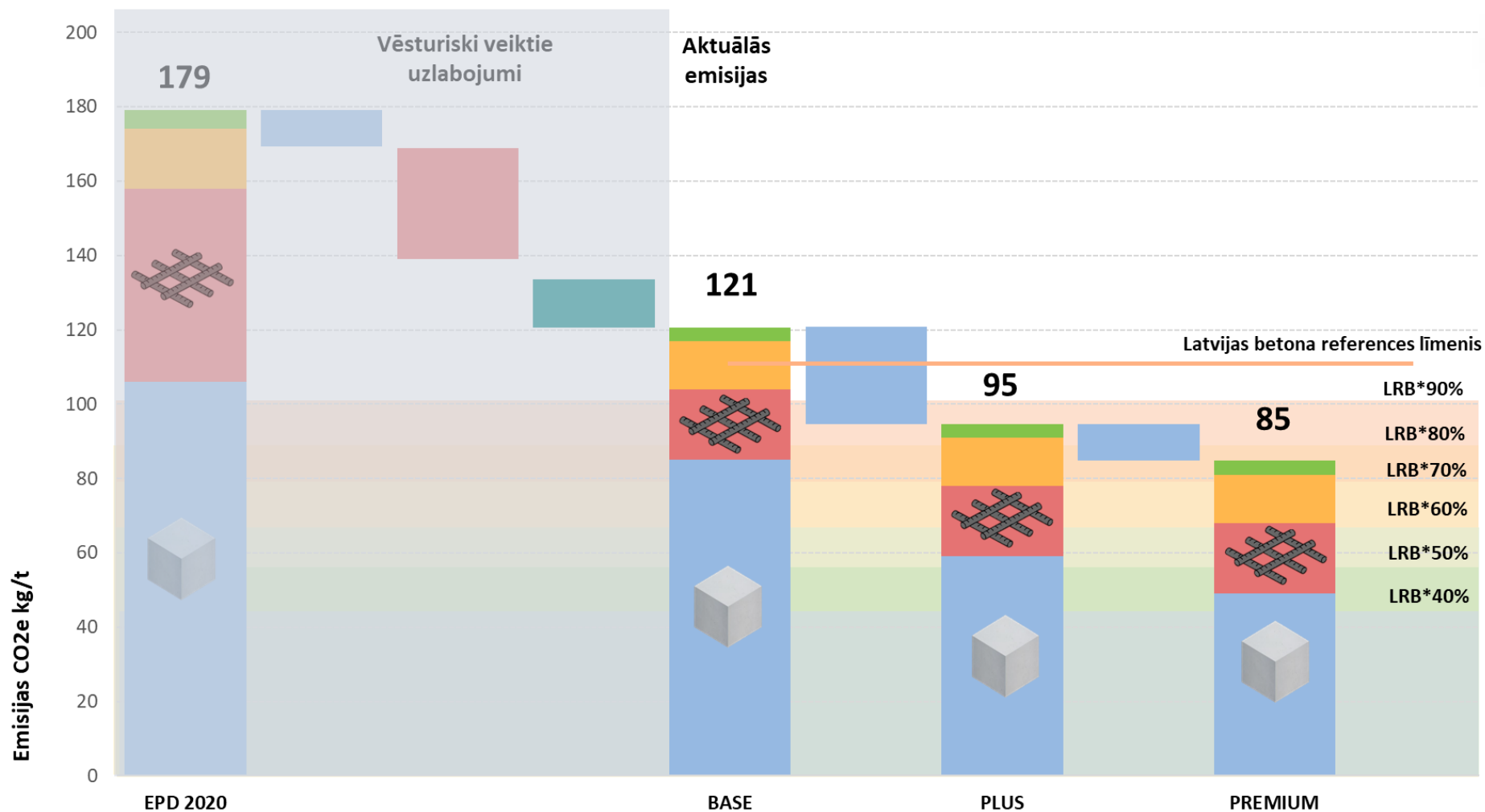
| Impact category                       | Unit                   | A1      | A2      | A3      | A1-A3   | A4 - SWE | A4-NOR  | A4-DK   | A4-UK   | A5      | B1-B7 | C1      | C2      | C3      | C4      | D        |
|---------------------------------------|------------------------|---------|---------|---------|---------|----------|---------|---------|---------|---------|-------|---------|---------|---------|---------|----------|
| Climate change – total                | kg CO <sub>2</sub> e   | 1,64E2  | 1,05E1  | 4,82E0  | 1,79E2  | 3,6E1    | 6,51E1  | 3,63E1  | 9,09E1  | 1,46E1  | MND   | 3,28E0  | 6,35E0  | 5,08E0  | 3,9E-1  | -1,52E1  |
| Climate change – fossil               | kg CO <sub>2</sub> e   | 1,61E2  | 1,05E1  | 4,81E0  | 1,77E2  | 3,57E1   | 6,45E1  | 3,6E1   | 9,01E1  | 1,41E1  | MND   | 3,27E0  | 6,32E0  | 4,89E0  | 3,88E-1 | -1,52E1  |
| Climate change – biogenic             | kg CO <sub>2</sub> e   | 2,96E0  | 8,26E-2 | 7,23E-3 | 3,05E0  | 1,61E-1  | 3,02E-1 | 1,56E-1 | 3,77E-1 | 4,68E-1 | MND   | 5,54E-3 | 3,76E-2 | 1,83E-1 | 2,46E-3 | 1,22E-2  |
| Climate change – LULUC                | kg CO <sub>2</sub> e   | 1,31E-1 | 4,39E-3 | 2,31E-4 | 1,36E-1 | 1,16E-2  | 2,03E-2 | 1,2E-2  | 3,09E-2 | 5,34E-3 | MND   | 2,79E-4 | 2,25E-3 | 1,97E-3 | 1,17E-4 | -9,05E-3 |
| Ozone depletion                       | kg CFC11e              | 6,74E-6 | 2,25E-6 | 7,2E-7  | 9,71E-6 | 8,32E-6  | 1,52E-5 | 8,31E-6 | 2,07E-5 | 1,48E-6 | MND   | 7,12E-7 | 1,46E-6 | 9,6E-7  | 1,63E-7 | -8,63E-7 |
| Acidification                         | mol H <sup>+</sup> e   | 5,4E-1  | 6,43E-2 | 6,63E-3 | 6,11E-1 | 2,52E-1  | 3,74E-1 | 2,98E-1 | 8,56E-1 | 8E-2    | MND   | 3,45E-2 | 2,62E-2 | 5,42E-2 | 3,75E-3 | -7,8E-2  |
| Eutrophication, aquatic freshwater    | kg PO <sub>4</sub> e   | 5,38E-3 | 1,12E-4 | 1,05E-5 | 5,5E-3  | 2,79E-4  | 5,15E-4 | 2,74E-4 | 6,71E-4 | 2,11E-4 | MND   | 1,33E-5 | 5,5E-5  | 1,16E-4 | 4,77E-6 | -7,84E-4 |
| Eutrophication, aquatic marine        | kg Ne                  | 1,25E-1 | 2,34E-2 | 2,24E-3 | 1,51E-1 | 7,65E-2  | 1,13E-1 | 9,08E-2 | 2,61E-1 | 2,86E-2 | MND   | 1,52E-2 | 7,77E-3 | 1,99E-2 | 1,29E-3 | -1,6E-2  |
| Eutrophication, terrestrial           | mol Ne                 | 1,4E0   | 2,57E-1 | 2,41E-2 | 1,88E0  | 8,44E-1  | 1,25E0  | 1E0     | 2,88E0  | 3,18E-1 | MND   | 1,67E-1 | 8,59E-2 | 2,21E-1 | 1,42E-2 | -1,96E-1 |
| Photochemical ozone formation         | kg NMVOCe              | 4,41E-1 | 7,37E-2 | 7,49E-3 | 5,22E-1 | 2,46E-1  | 3,77E-1 | 2,85E-1 | 8,06E-1 | 8,64E-2 | MND   | 4,59E-2 | 2,7E-2  | 6,08E-2 | 4,13E-3 | -7,53E-2 |
| Abiotic depletion, minerals & metals  | kg Sbe                 | 1,46E-3 | 1,9E-4  | 4,04E-6 | 1,66E-3 | 7,42E-4  | 1,24E-3 | 8,05E-4 | 2,15E-3 | 6,9E-4  | MND   | 5,03E-6 | 1,59E-4 | 8,73E-5 | 3,61E-6 | -7,97E-4 |
| Abiotic depletion of fossil resources | MJ                     | 1,22E3  | 1,54E2  | 7,94E1  | 1,45E3  | 5,46E2   | 9,98E2  | 5,43E2  | 1,34E3  | 1,24E2  | MND   | 4,54E1  | 9,72E1  | 6,81E1  | 1,1E1   | -1,62E2  |
| Water use                             | m <sup>3</sup> e depr. | 3,93E1  | 6,86E-1 | 8,43E-2 | 4E1     | 1,94E0   | 3,62E0  | 1,88E0  | 4,55E0  | 1,48E0  | MND   | 8,46E-2 | 3,45E-1 | 3,8E-1  | 5,11E-1 | -1,39E1  |

EN 15804+A2 disclaimer for Abiotic depletion and Water use indicators and all optional indicators except Particulate matter and Ionizing radiation, human health: The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator. Eutrophication aquatic freshwater is reported as *kg PO<sub>4</sub>eq*, although the reference given ("EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe") uses the unit *kg P eq*.

# Co2 piensesums no produktiem



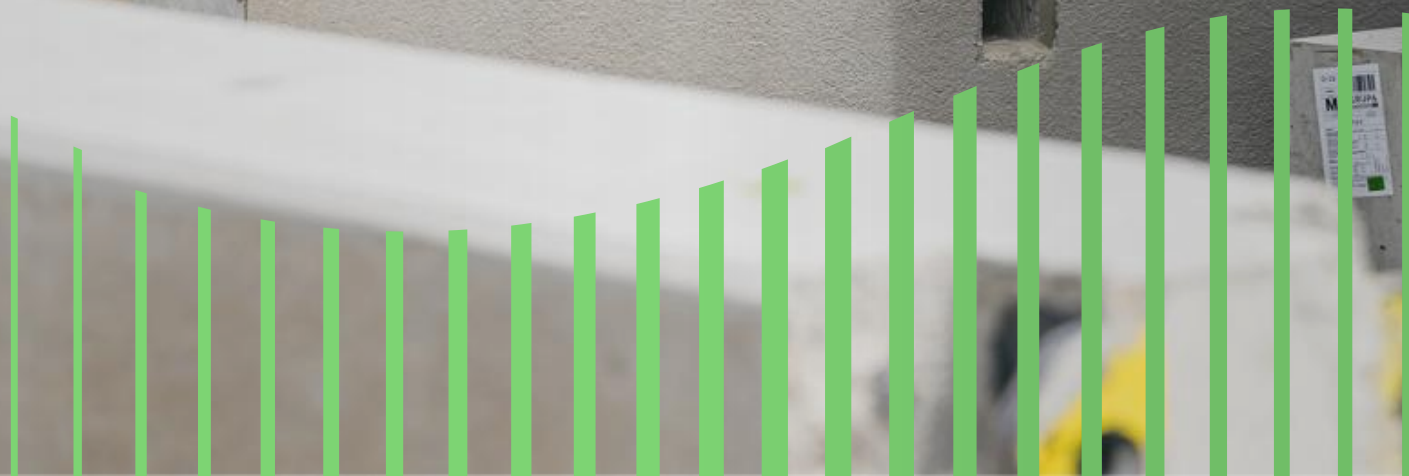
# Vienslāņu sienas





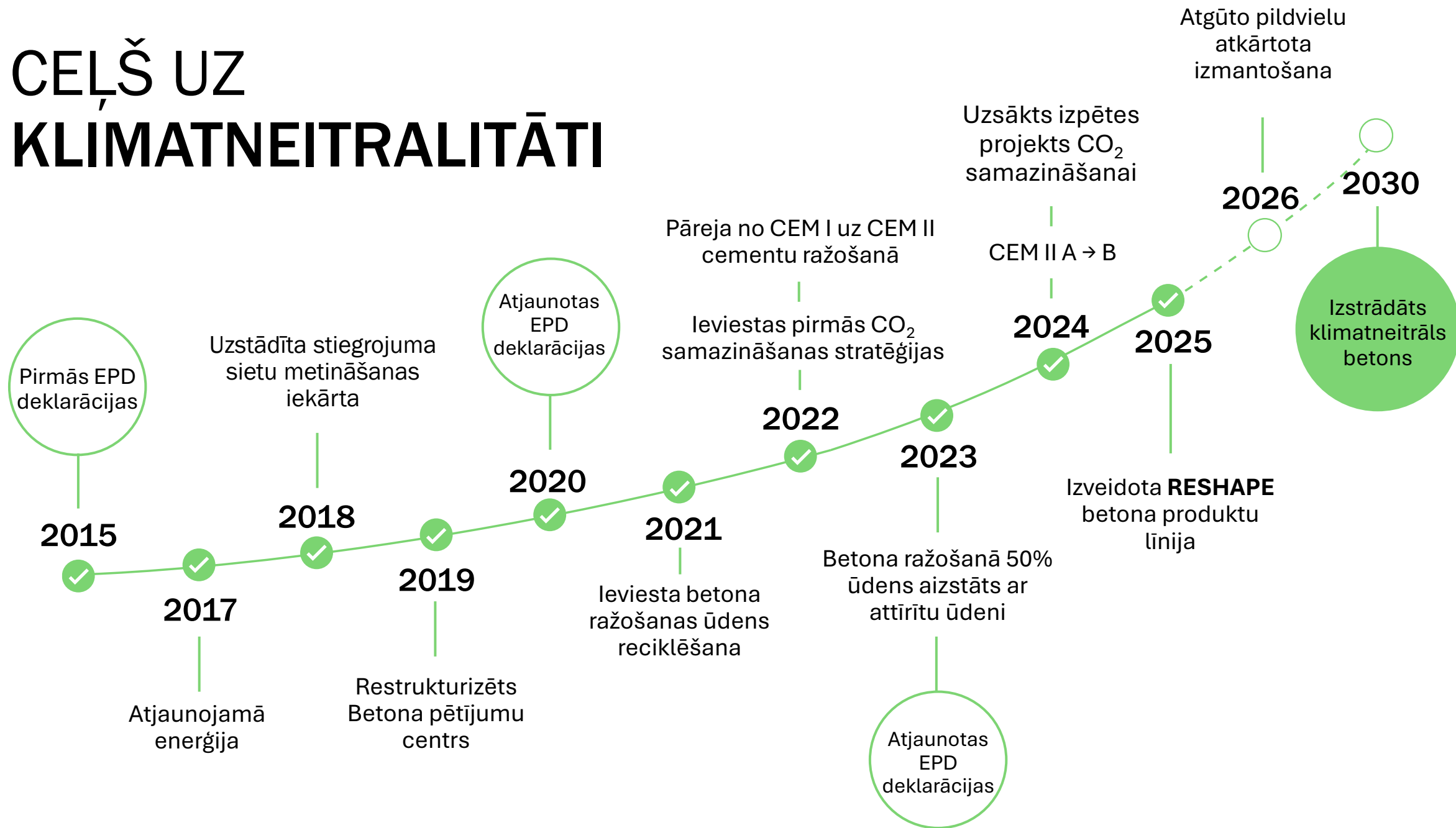
# RESHAPE BETONS

Produktu līnija ar samazinātu CO2 apjomu

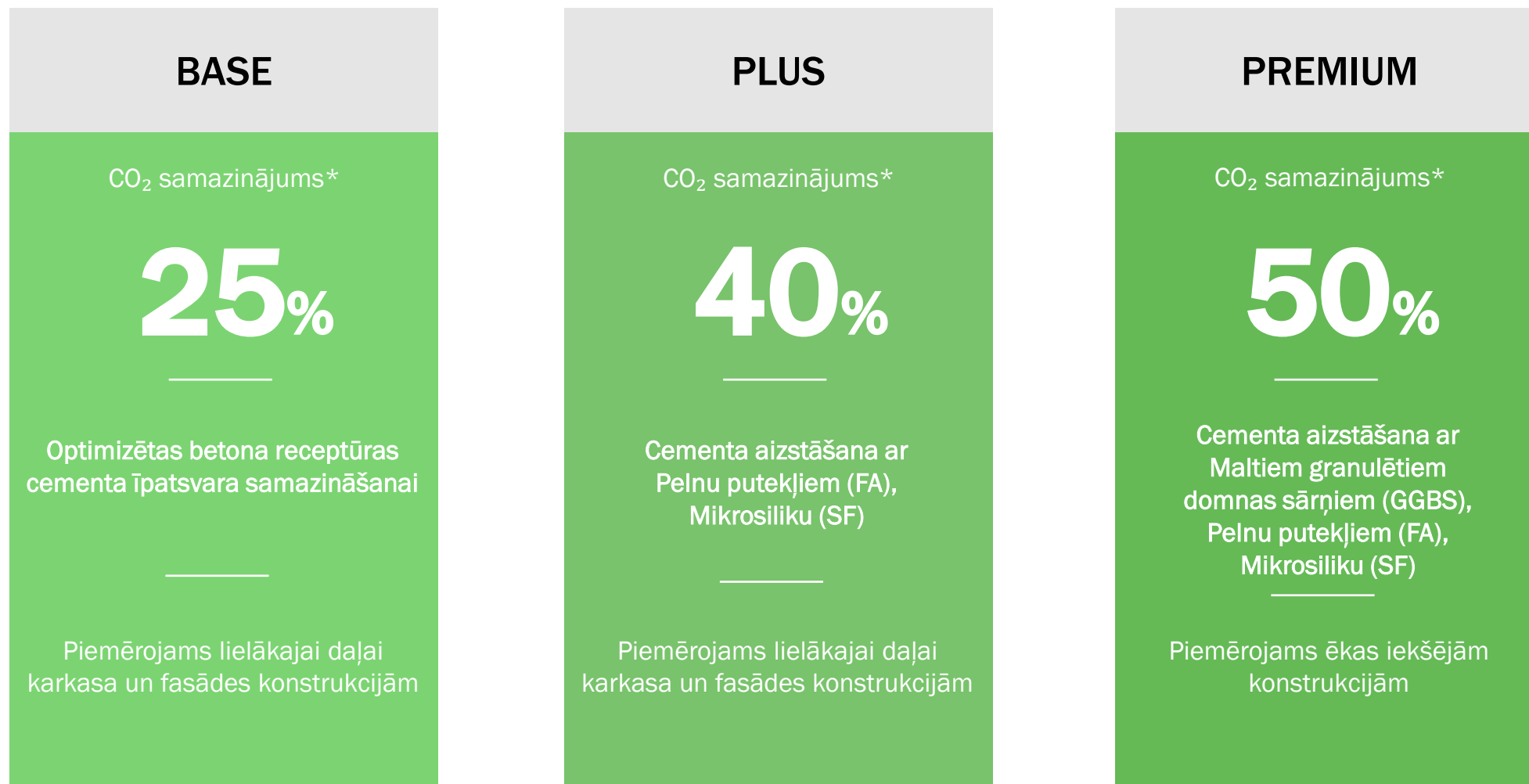




# CEĻŠ UZ KLIMATNEITRALITĀTI



# RESHAPE BETONA LĪMENI

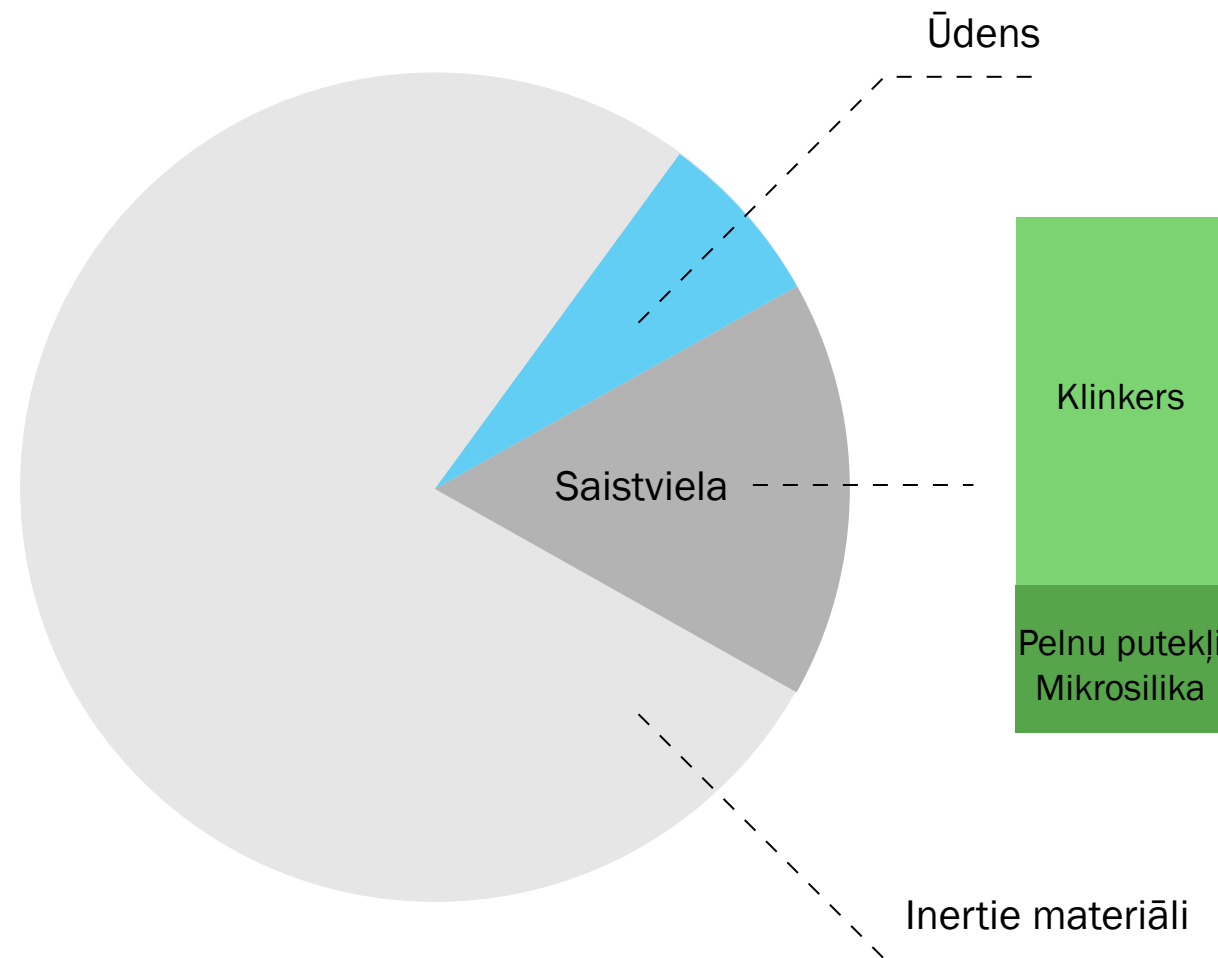


\*Salīdzinot ar Svensk Betong industrijas līmeni

# RESHAPE PLUS BETONS

## APSVĒRUMI:

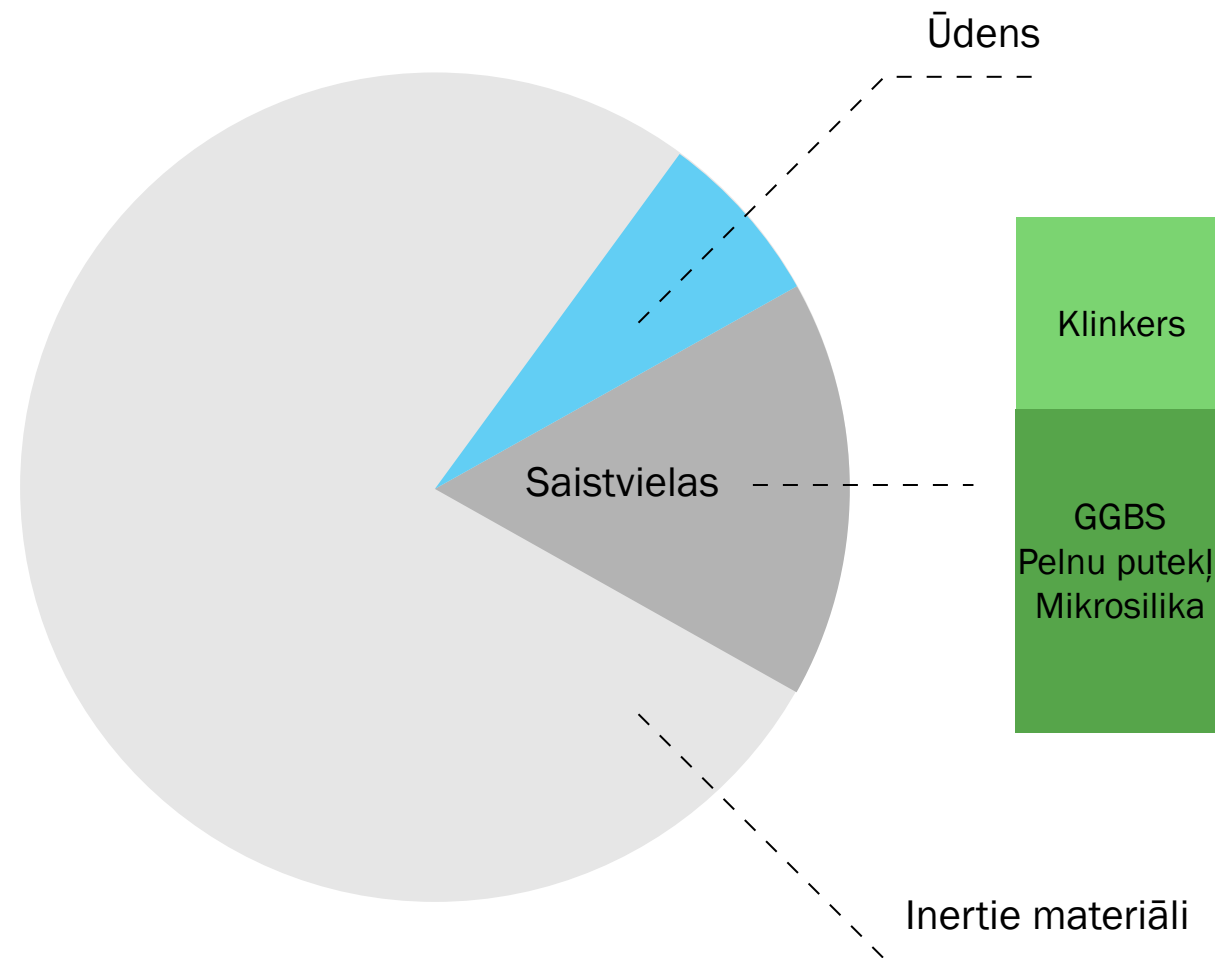
- Nav piemērots vidēm ar sasalšanas / atkuššanas iedarbību un pretapledošanas vielām
- Lēna agrīnā stiprības attīstība
- Nepieciešama stabila piegādes ķēde
- Nepieciešama specializēta silosu infrastruktūra



# RESHAPE PREMIUM BETONS

## APSVĒRUMI:

- Ierobežotām vides iedarbības klasēm
- Nepieciešama papildu veikspējas pārbaude
- Ievērojami samazināts agrīnās izturības pieaugums
- Nepieciešama stabila piegādes ķēde
- Nepieciešama specializēta silosu infrastruktūra







20% CO<sub>2</sub> samazinājums\*

HARVESTAD  
Pansionāts

 Linšēpinga, Zviedrija



- Izmantots RESHAPE Plus betons, aizstājot 50% klinkera apjomu
- Dzelzsbetona fasādes sienās integrēti atkārtoti izmantoti ķieģeļi

\*Salīdzinot ar mūsu standarta EPD rezultātu



30% CO<sub>2</sub> samazinājums\*

OLIVIN  
Office Building

 Stockholm, Sweden



- Optimizācijas projektēšanas posmā
- Karkasā integrētas atkārtoti izmantotas dzelzsbetona konstrukcijas
- Izmantots RESHAPE Plus betons, aizstājot 50% klinkera apjomu
- Samazinātas kopējās projekta izmaksas



\*Salīdzinot ar mūsu standarta EPD rezultātu

PALDIES!

Uzzini vairāk:



**MB**GRUPA | RESHAPE

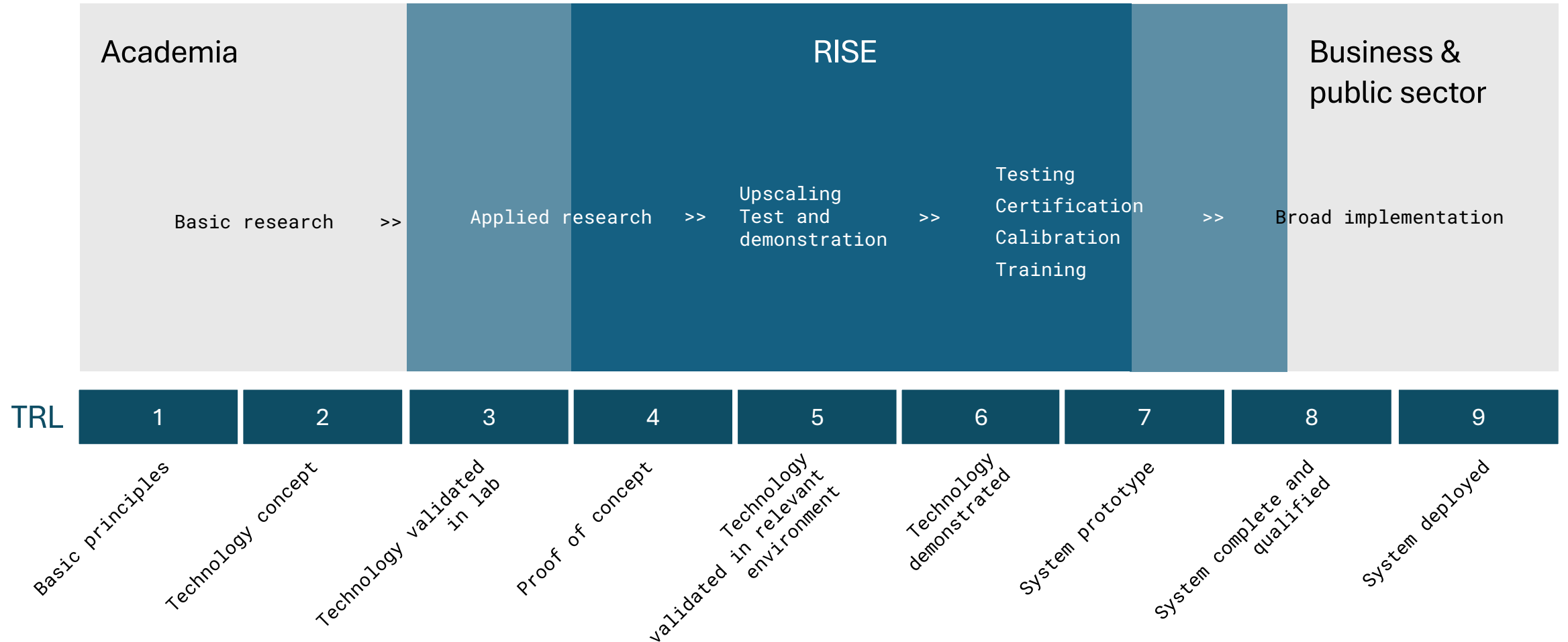
# Swedish Perspectives on Sustainable Construction

*Katarina Malaga*

*Vice President Business Development  
Build Environment- Sustainable Construction  
Research Institutes of Sweden*

*2025-11-27, Riga, Latvia*

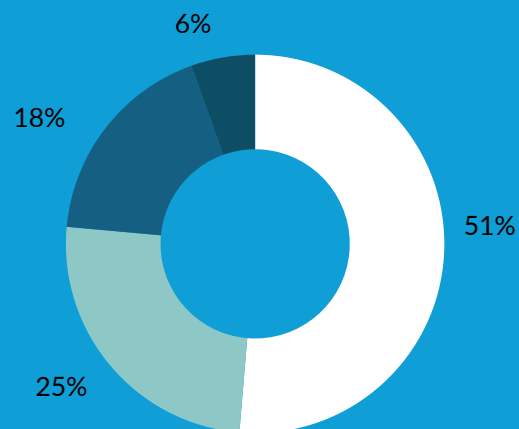
# RISE in the innovation value chain





# 430

Million Euro, net sales



Revenue distribution

|                                                                                     |                 |            |
|-------------------------------------------------------------------------------------|-----------------|------------|
|  | Business sector | 2,222 MSEK |
|  | Public funds    | 1,087 MSEK |
|  | State funds     | 783 MSEK   |
|  | EU funds        | 237 MSEK   |

Approximately

# 3,300

employees

# 4th

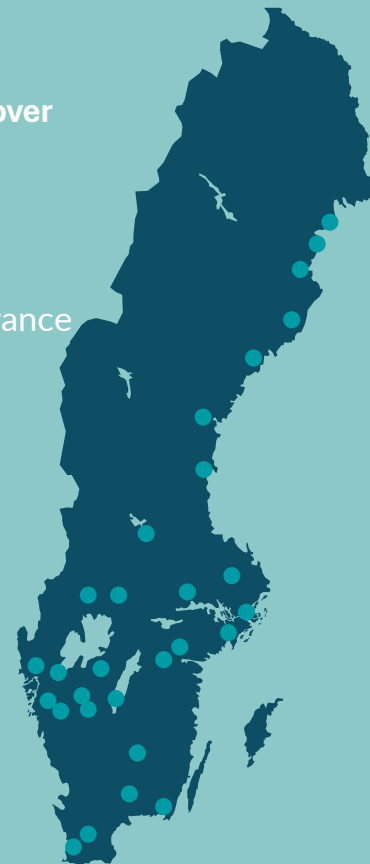
Largest institute in Europe after Fraunhofer, CEA, and TNO

# 130+

Test and demonstration facilities

Our operations  
are located all over  
Sweden

We also have  
operations in  
Norway and France



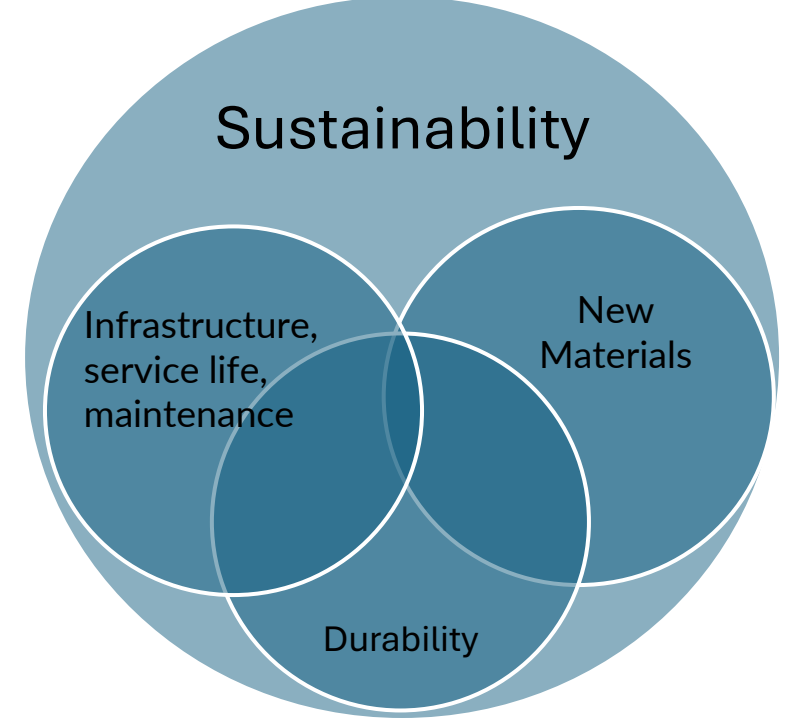
# 40%

# women

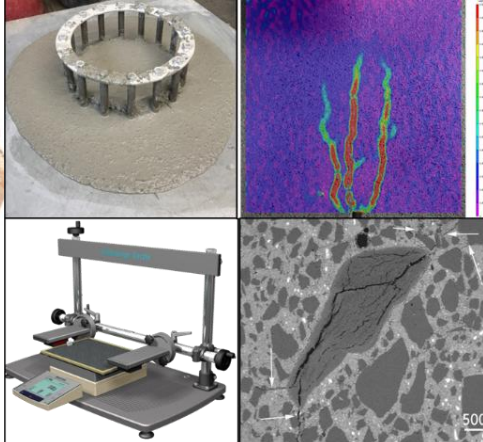
# Cement-concrete working areas

Main areas:

- R&D projects,
- Characterization and testing,
- Consulting
  - Quality control
  - Assessment (damages, materials)
- Certification and regulatory



Binder chemistry



Applied concrete technology



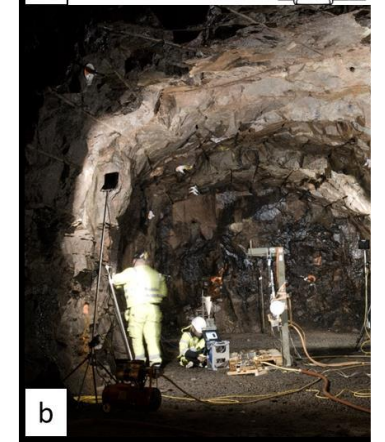
Structures durability and service-life



Recycling, circularity and CCS/CCU



3D printing



Dynamic Injections



# Cement production in Sweden

In 19-century: 15 production sites for Portland cement

Today: 2 production sites

Heidelberg Materials Cement Sweden AB





# Production and use of cement in Sweden

- **2.8 -3.4 M t /y (ca 300 kg/person)**
  - Heidelberg materials cement Sweden
  - Import from Latvia– Schwenk (300-400 kt)
  - Import Heidelberg Materials Norway:
    - ‘evoZero’ (CCS)
- **Infrastructure FA - CEM II/A-V 42,5 N - MH/LA/NSR**
- **Basic cement Plus - CEM II/B-M (P-LL)**
- **Basic cement Slite - CEM II/A-LL 42,5 R**
- **Industrial cement Slite- CEM II/A-LL 52,5 R**
- **Industrial cement Skövde - CEM II/A-LL 52,5 R**
- **Construction cement Skövde - CEM II/A-LL 42,5 R**
- **Rapidcement -CEM I 52,5 R**
- **evoZero (Norway)**

[Bygg & anläggningscement | Heidelberg Materials](#)

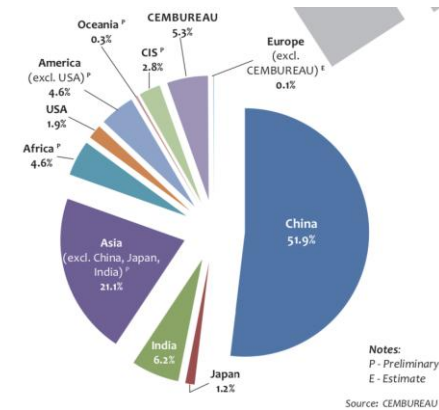
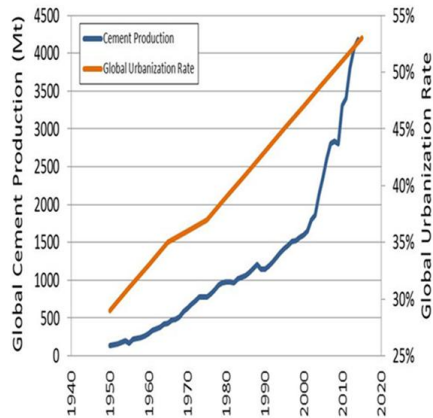


# Why Sustainability in Concrete?

CO<sub>2</sub>

## Global Concrete Demand

Urbanization drives demand for housing, increasing concrete use with a large environmental footprint.



## Environmental Impact of Cement (7-8%)

Cement production is energy-intensive and produces significant CO<sub>2</sub> emissions from clinker formation.



# Total global estimate of CO<sub>2</sub> emissions Concrete (2022)

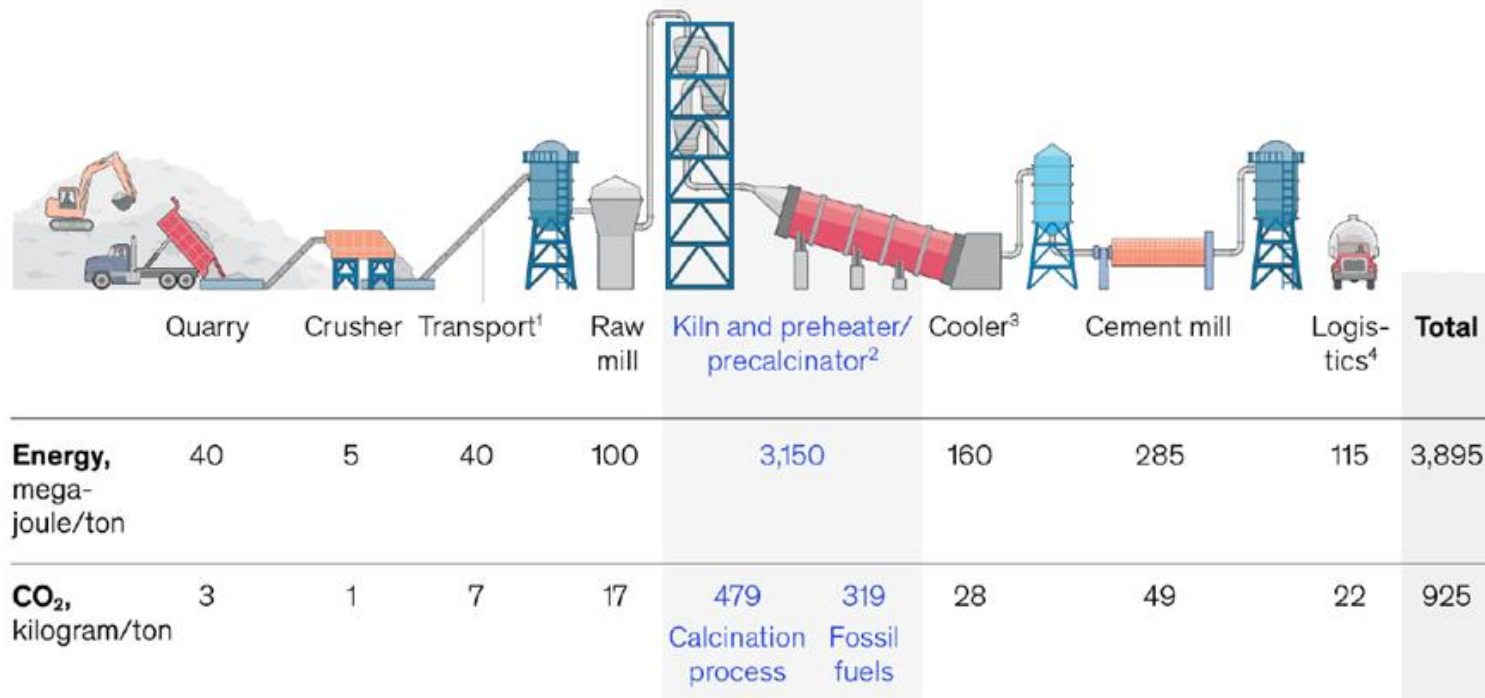
- Cement – 4.1 billion t
- Emission intensity of:
  - **0.39** or **0.6** or **0.85** t of CO<sub>2</sub> per t of cement
  - **1.6** or **2.4** or **3.5 billion t/year**
  - **Sweden – ca 2 Mt/year of CO<sub>2</sub>**

*The International Energy Agency (IEA) notes that the emissions intensity has remained relatively stable since 2018, at just under 0.6 t CO<sub>2</sub> per tonne of cement produced.*

## Cement manufacturing is a highly complex process.

Raw materials, energy,  
and resources

Clinker and cement manufacturing



<sup>1</sup> Assumed with 1kWh/t/100m.

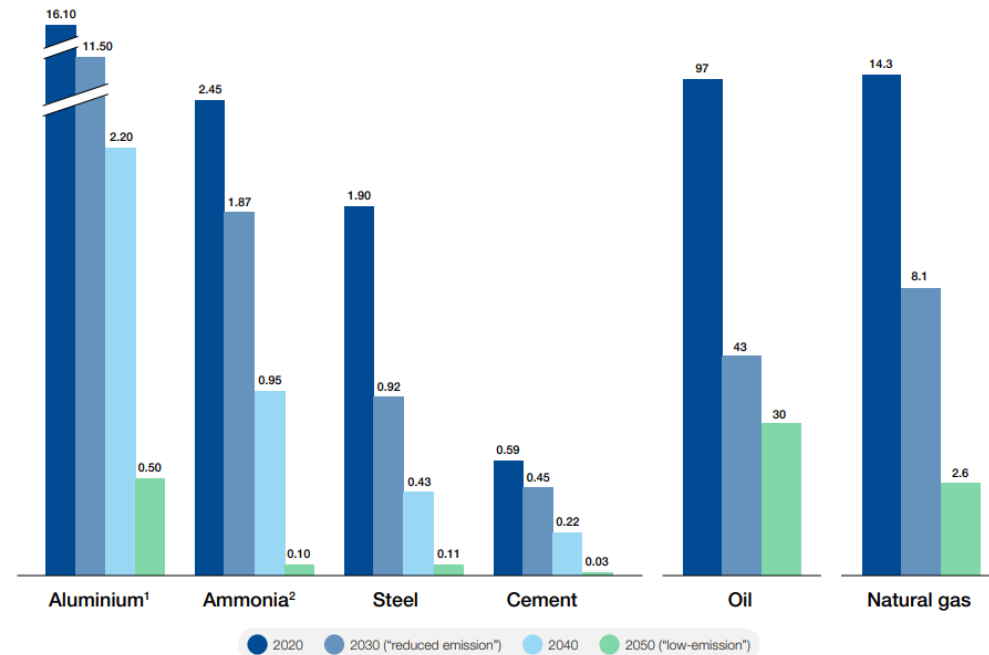
<sup>2</sup> Assumed global average, data from the Global Cement and Concrete Association, Getting the Numbers Right 2017.

<sup>3</sup> Assumed reciprocating grate cooler with 5kWh/t clinker.

<sup>4</sup> Assumed lorry transportation for average 200km.

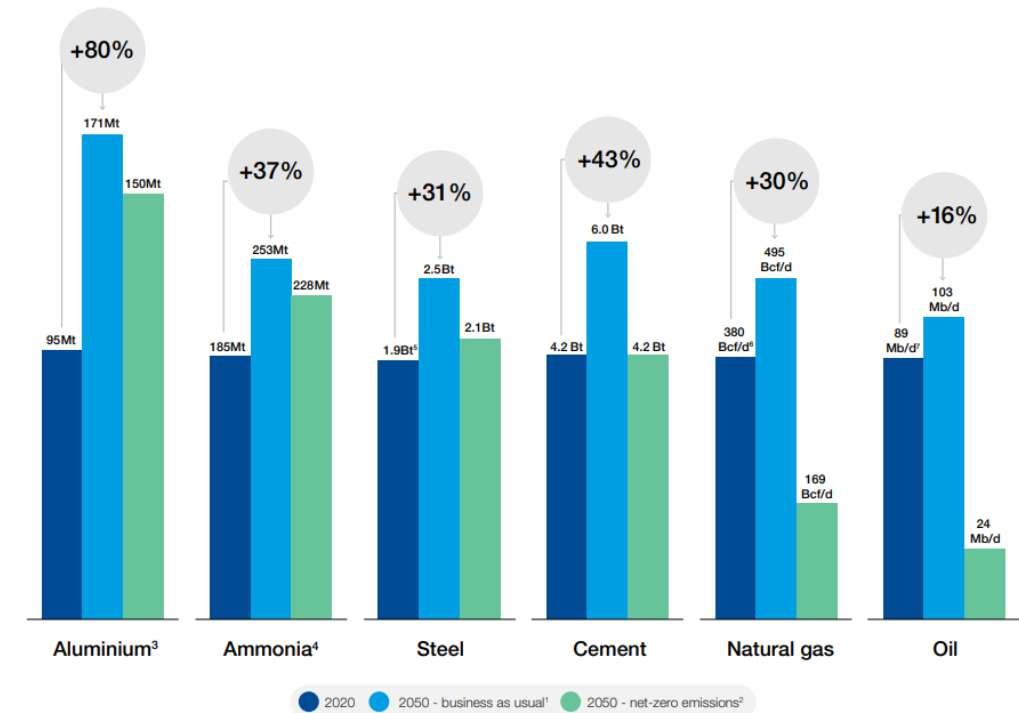
# Emissions and production in the future (2020-2050)

Basic materials industry emission intensity trajectory (2020-2050)  
(tCO<sub>2</sub>e/t production)<sup>5</sup>



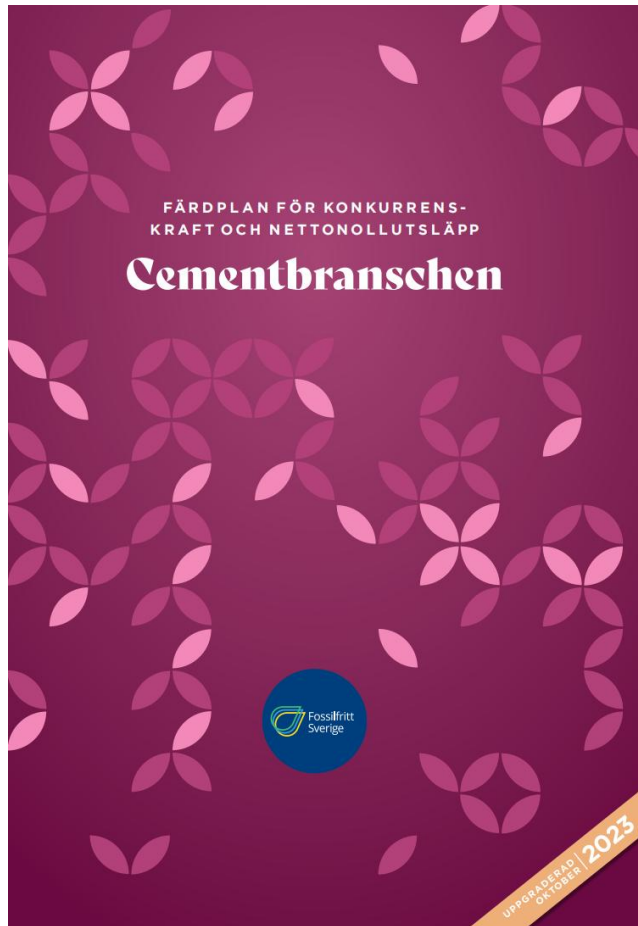
Energy industry emission intensity trajectory (2020-2050)<sup>3</sup>  
(kgCO<sub>2</sub>e/bbl and tCO<sub>2</sub>e/MMcf)<sup>6,7</sup>

Production increase from 2020 to 2050 under business-as-usual (BAU) and IEA Net Zero by 2050 scenarios

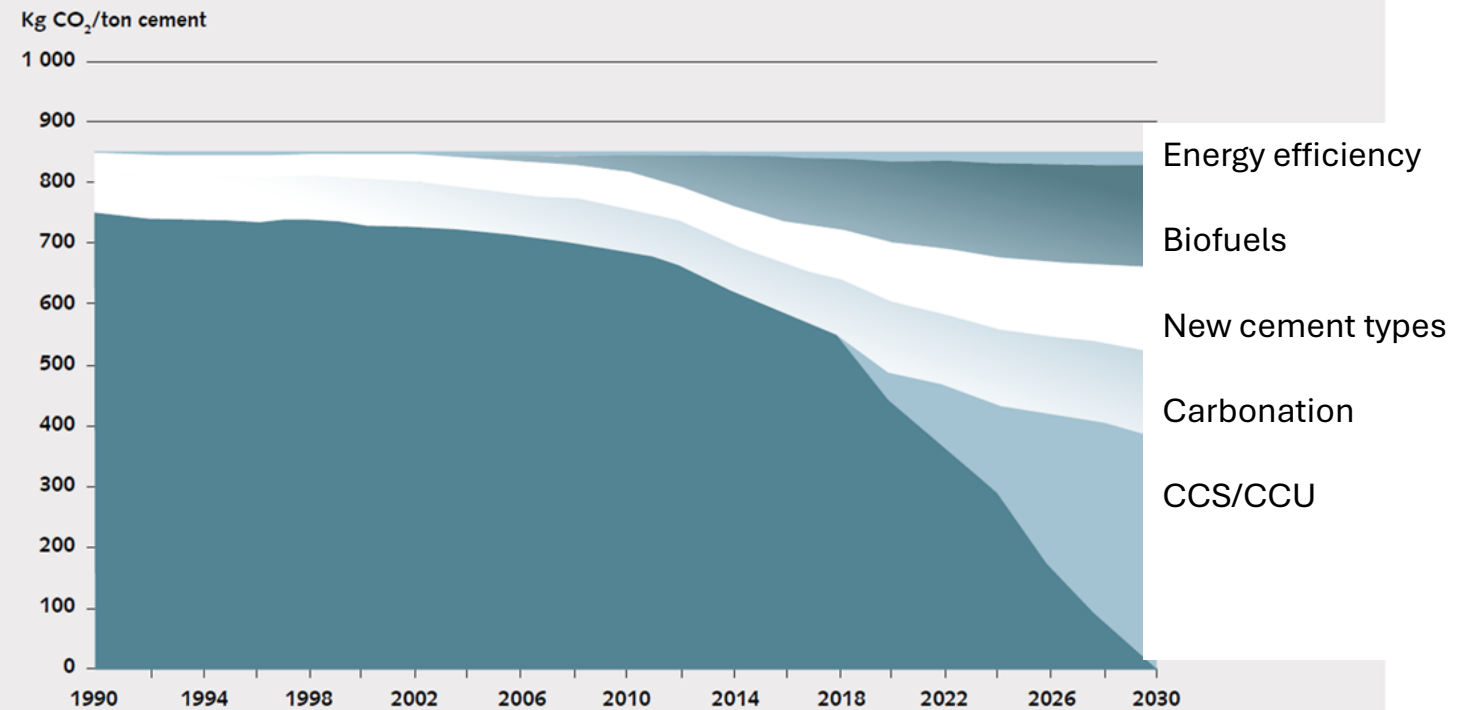




# Challenges and the progress - Sweden



## Zero-vision for Swedish cement production



# Swedish Roadmap & Policy Drivers



Betong – Naturliga puzzoloner och aktiverade naturliga puzzoloner – Terminologi, specifikationer och kriterier för överensstämmelse  
Concrete – Natural pozzolana and activated natural pozzolana – Terminology, specifications and conformity criteria

## Policy Frameworks

Sweden's sustainable construction relies on policies like EU ETS and CBAM to reduce carbon emissions and encourage low-carbon materials.

## Climate Declarations & Standards

Mandatory climate declarations and standards like SS 137003 and EN 206 promote verified low-carbon concrete in construction projects.

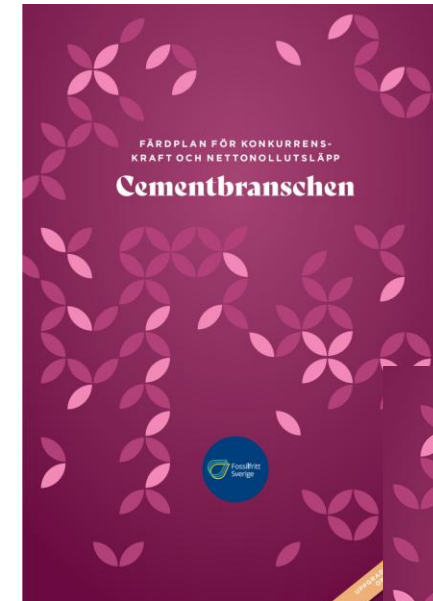
- Content verification



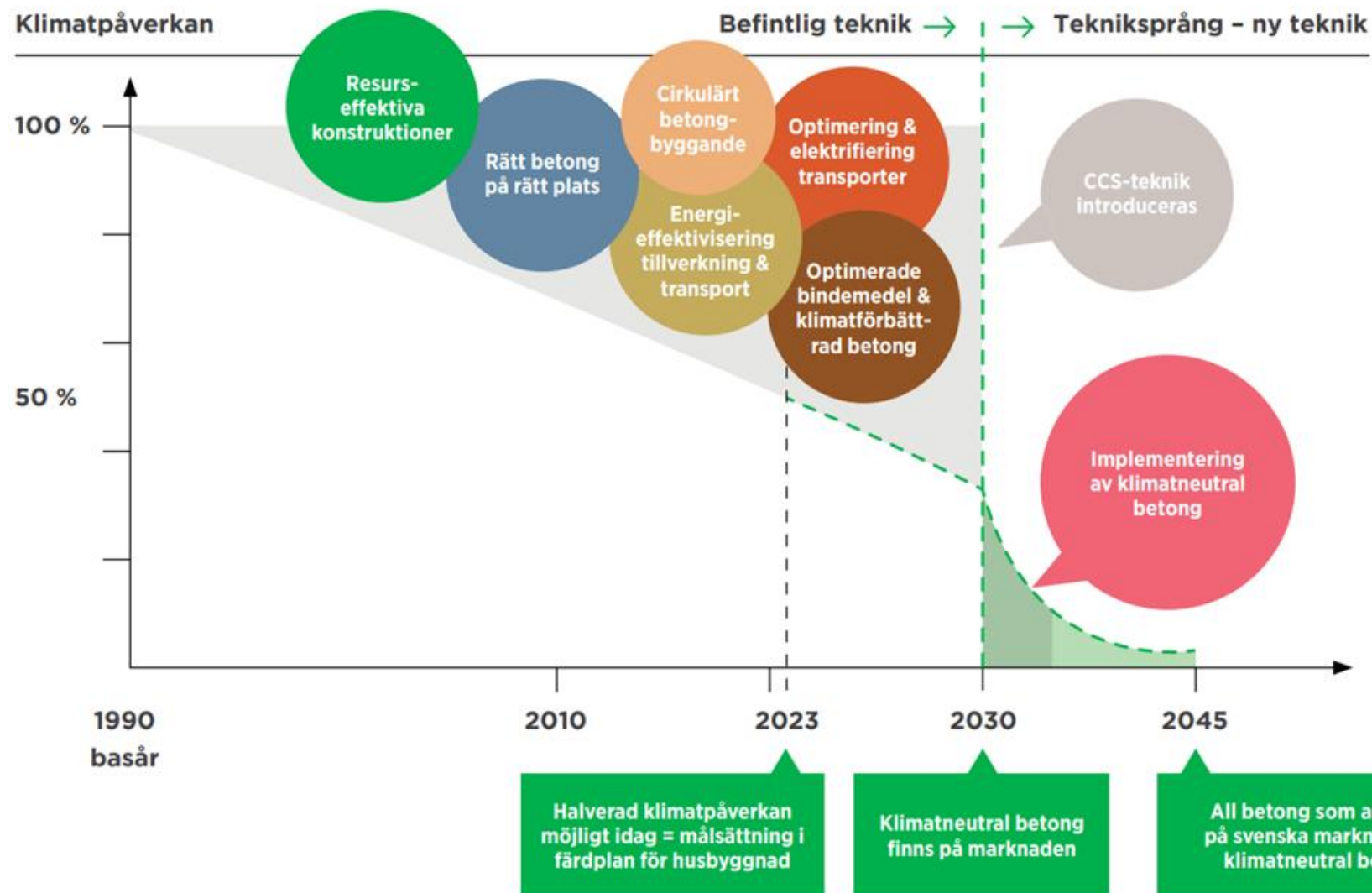
sis Svenska Institutet för Standarder

## Innovative Materials & Technologies

Adoption of blended cements, supplementary cementitious materials, carbon capture, and carbonation technologies supports deep decarbonization.



# Svensk Betong - Guidance



# Climate-improved concrete guidance



| Fabriksbetong<br>Tabell 1                                                                   | Exponerings-<br>klass | Hållfasthets-<br>klass* | vct <sub>ekv</sub> * | Klimatpåverkan GWP-GHG, kg CO <sub>2</sub> -ekv/m <sup>3</sup> |        |                       |        |          |
|---------------------------------------------------------------------------------------------|-----------------------|-------------------------|----------------------|----------------------------------------------------------------|--------|-----------------------|--------|----------|
|                                                                                             |                       |                         |                      | Bransch-<br>referens                                           | Nivå 1 | Klimatförbättrad, max |        |          |
| Hus Invändigt                                                                               | X0, XC1               | C50/60                  | 0,35                 | 365                                                            | 330    | 290                   | 255    | ≤ 220    |
|                                                                                             |                       |                         |                      |                                                                |        |                       |        |          |
| RF <sub>krav</sub> < 85%, tex plastmatta och vissa fall parkett                             | X0, XC1               | C35/45                  | 0,45                 | 305                                                            | 275    | 245                   | 215    | ≤ 185    |
| RF <sub>krav</sub> < 90%, tex balklag                                                       |                       |                         |                      |                                                                |        |                       |        |          |
| Hus Invändigt<br>Inomhus med låg fuktighet                                                  | X0, XC1               | C30/37                  | 0,55                 | 255                                                            | 230    | 205                   | 180    | ≤ 155    |
|                                                                                             | X0, XC1               | C28/35                  | 0,60                 | 240                                                            | 215    | 190                   | 170    | ≤ 145    |
|                                                                                             | X0, XC1               | C25/30                  | 0,65                 | 225                                                            | 205    | 180                   | 160    | ≤ 135    |
|                                                                                             | X0, XC1               | C16/20                  | 0,70                 | 205                                                            | 185    | 165                   | 145    | ≤ 125    |
| Parkeringshus<br>Slutet, uppvärmt, utsatt för saltstänk                                     | XD3                   | C40/50                  | 0,40**               | 340                                                            | 305    | 270                   | 240    | ≤ 205    |
| Grundkonstruktioner<br>Frostfritt under GVV                                                 | XC1                   | C30/37                  | 0,55                 | 255                                                            | 230    | 205                   | 180    | ≤ 155    |
|                                                                                             |                       |                         |                      |                                                                |        |                       |        |          |
| Ej Frostfritt över/under GVV                                                                | XC3, XC4, XF3         | C28/35                  | 0,55**               | 270                                                            | 245    | 215                   | 190    | ≤ 160    |
| Hus Utomhus, ej salt<br>Yttervägg, balkong, sockel                                          | XC3, XC4, XF3         | C28/35                  | 0,55**               | 270                                                            | 245    | 215                   | 190    | ≤ 160    |
| Hus Utomhus, salt<br>Parkeringshus, kallt                                                   | XD3, XF2              | C35/45                  | 0,40**               | 340                                                            | 305    | 270                   | 240    | ≤ 205    |
| Anläggning Utomhus, salt<br>och frost se Betongrapport 11<br>Utanför zon 2. Tex. stödmurar. | XC4, XF3              | C28/35                  | 0,50**               | 325                                                            | 290    | 260                   | 225    | ≤ 195    |
|                                                                                             |                       |                         |                      |                                                                |        |                       |        |          |
| I zon 2, ej i stänkkon.                                                                     | XD2, XS2, XF2         | C32/40                  | 0,45**               | 355                                                            | 320    | 285                   | 250*** | ≤ 215*** |
| Töslatade vägar och vägbroar,<br>konstruktioner i eller invid<br>havsvatten                 | XD3, XS3, XF4         | C35/4                   |                      |                                                                |        |                       |        |          |

\* Typiska värden/klasser. Styrts främst av exponeringsklass och i vissa fall av vct<sub>ekv</sub>.

\*\* Max vct<sub>ekv</sub> i exponeringsklassen enligt SS 137003:2021 samt tillämpliga standarder och regelverk i Sverige begränsar möjlig reduktion.

\*\*\* Svensk Betong Vägledning Klimatförbättrad betong utgåva 2.0

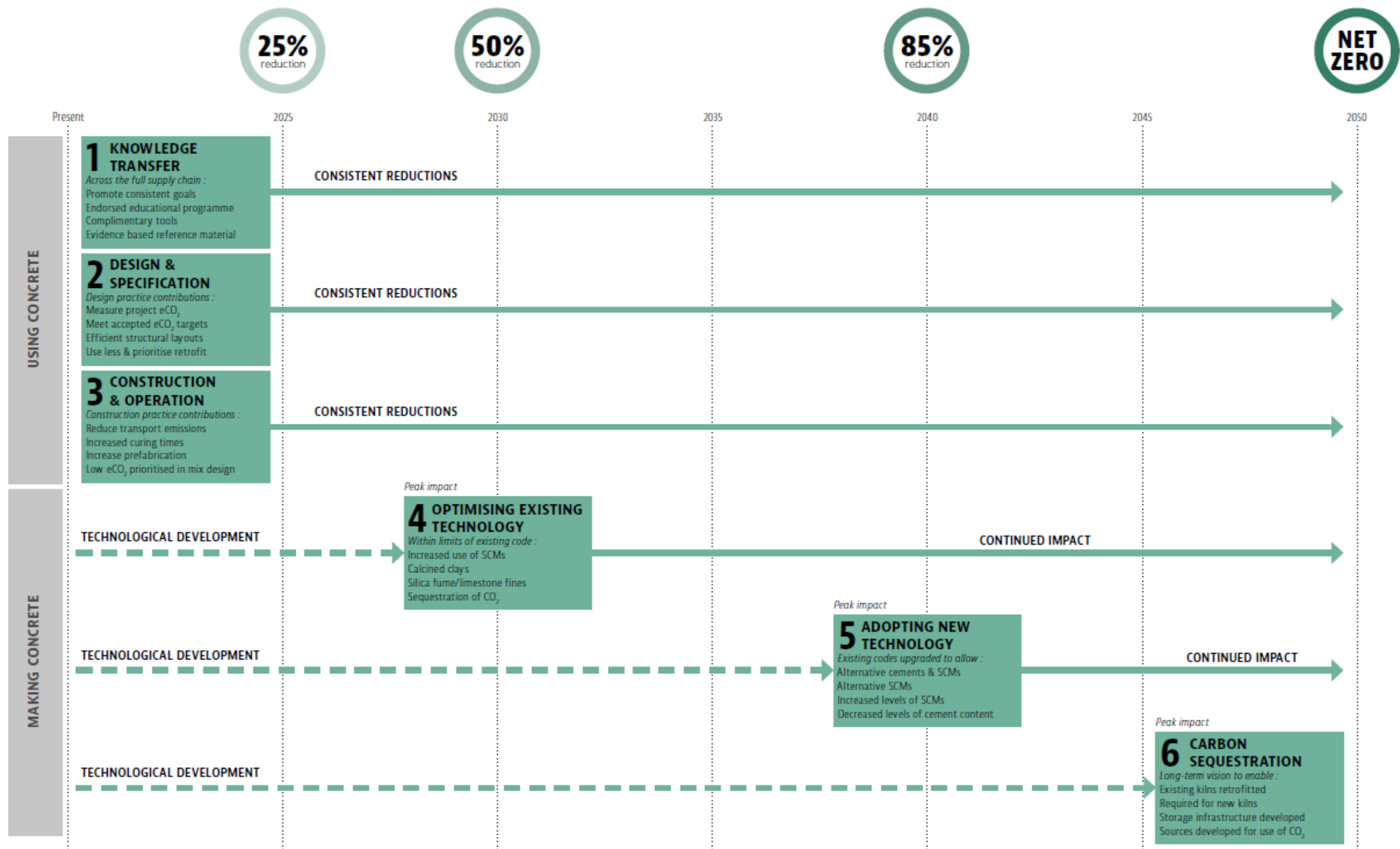
Tabell 1: Exempel på beräknad klimatpåverkan, A1-A3, från fabriksbetong. Klimatförbättras. Branschreferenserna är uppskattade medelvärden för 157804 + A1. Variationer förekommer beroende på förutsättning, procent reduktion eller mer i förhållande till en branschreferens och produktionstekniska förutsättningar. För omräkning

| Fabriksbetong<br>Tabell 2                  | Exponerings-<br>klass | Hållfasthets-<br>klass* | vct <sub>ekv</sub> * | Klimatpåverkan GWP-GHG, kg CO <sub>2</sub> -ekv/m <sup>3</sup> |        |                       |     |       |
|--------------------------------------------|-----------------------|-------------------------|----------------------|----------------------------------------------------------------|--------|-----------------------|-----|-------|
|                                            |                       |                         |                      | Bransch-<br>referens                                           | Nivå 1 | Klimatförbättrad, max |     |       |
| Hus invändigt                              | X0, XC1               | C50/60                  | 0,35                 | 365                                                            | 330    | 290                   | 255 | ≤ 220 |
|                                            |                       |                         |                      |                                                                |        |                       |     |       |
| Hus invändigt                              | X0, XC1               | C35/45                  | 0,45                 | 305                                                            | 275    | 245                   | 215 | ≤ 185 |
|                                            |                       |                         |                      |                                                                |        |                       |     |       |
| Hus invändigt<br>Inomhus med låg fuktighet | X0, XC1               | C30/37                  | 0,55                 | 255                                                            | 230    | 205                   | 180 | ≤ 155 |
|                                            |                       | C28/35                  | 0,60                 | 240                                                            | 215    | 190                   | 170 | ≤ 145 |
|                                            |                       | C25/30                  | 0,65                 | 225                                                            | 205    | 180                   | 160 | ≤ 135 |
|                                            |                       | C16/20                  | 0,70                 | 205                                                            | 185    | 165                   | 145 | ≤ 125 |

Svensk Betong Vägledning Klimatförbättrad betong utgåva 2.0

Tabell 2: Utdrag ur tabell 1 där pilarna illustrerar hur man genom att välja, dels rätt betongkvalitet, (vertikal förflyttning i tabellen), dels en klimatförbättrad betong, (horisontell förflyttning i tabellen), kan uppnå stor reduktion av CO<sub>2</sub>-utsläpp.





# Omvärldsanalys –Storbritannien (2022 april)



Knowledge



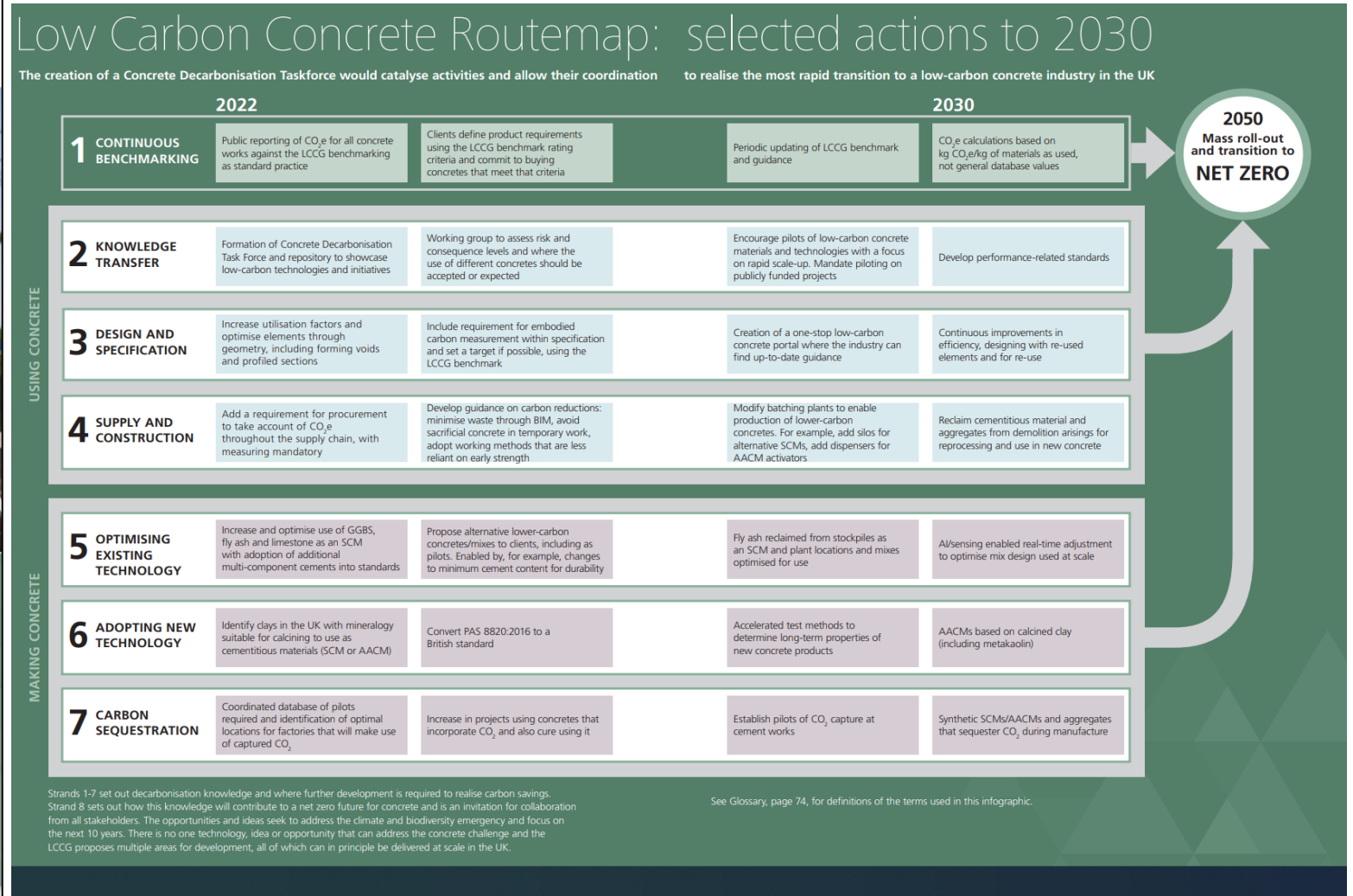


Low Carbon Concrete  
Routemap

Setting the agenda for a path to net zero

Low Carbon Concrete Group  
The Green Construction Board

ice.org.uk



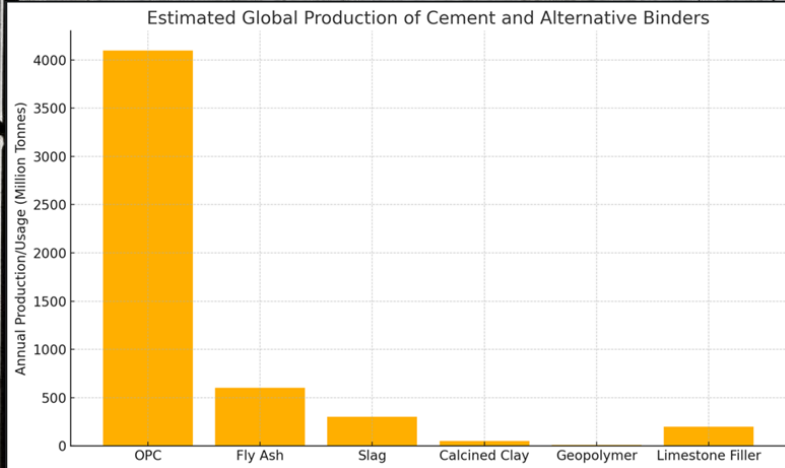




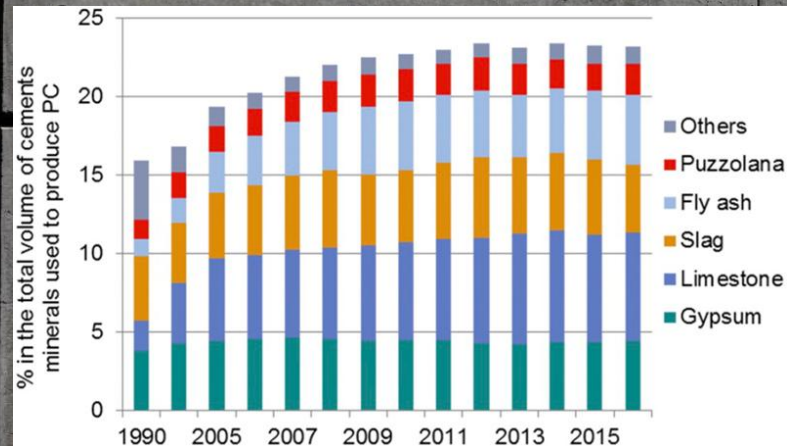
## BETCRETE 1.0-2.0-3.0 – national implementation initiative (research-innovation project)

- 30 industrial partners
- Concrete producers' association
- Technical consultants
- Authorities
- University

## Reduction of Clinker Content – by what?



## • Use of Supplementary Cementitious Materials



‘Right material for right application’

## Focus on CO<sub>2</sub>- neutrality Cement & Concrete in Sweden

- **Challenges and Local Resource Exploration**
- Limited availability of fly ash and slag drives exploration of **alternative materials** such as clays, vulcanic pozzolans from Island, industrial pozzolan...
- **Climate-Improved Concrete and Market Trends**
- Rising demand for climate-improved concrete is supported by updated **standards, procurement policies, and innovation collaboration.**



*concerning 'Right material for right application'*

## Clinker content in concrete since 1940 Sweden

CBI Stockholm - 1944



275 kg clinker/m<sup>3</sup>

Modern house



350-400-500 kg clinker/m<sup>3</sup>

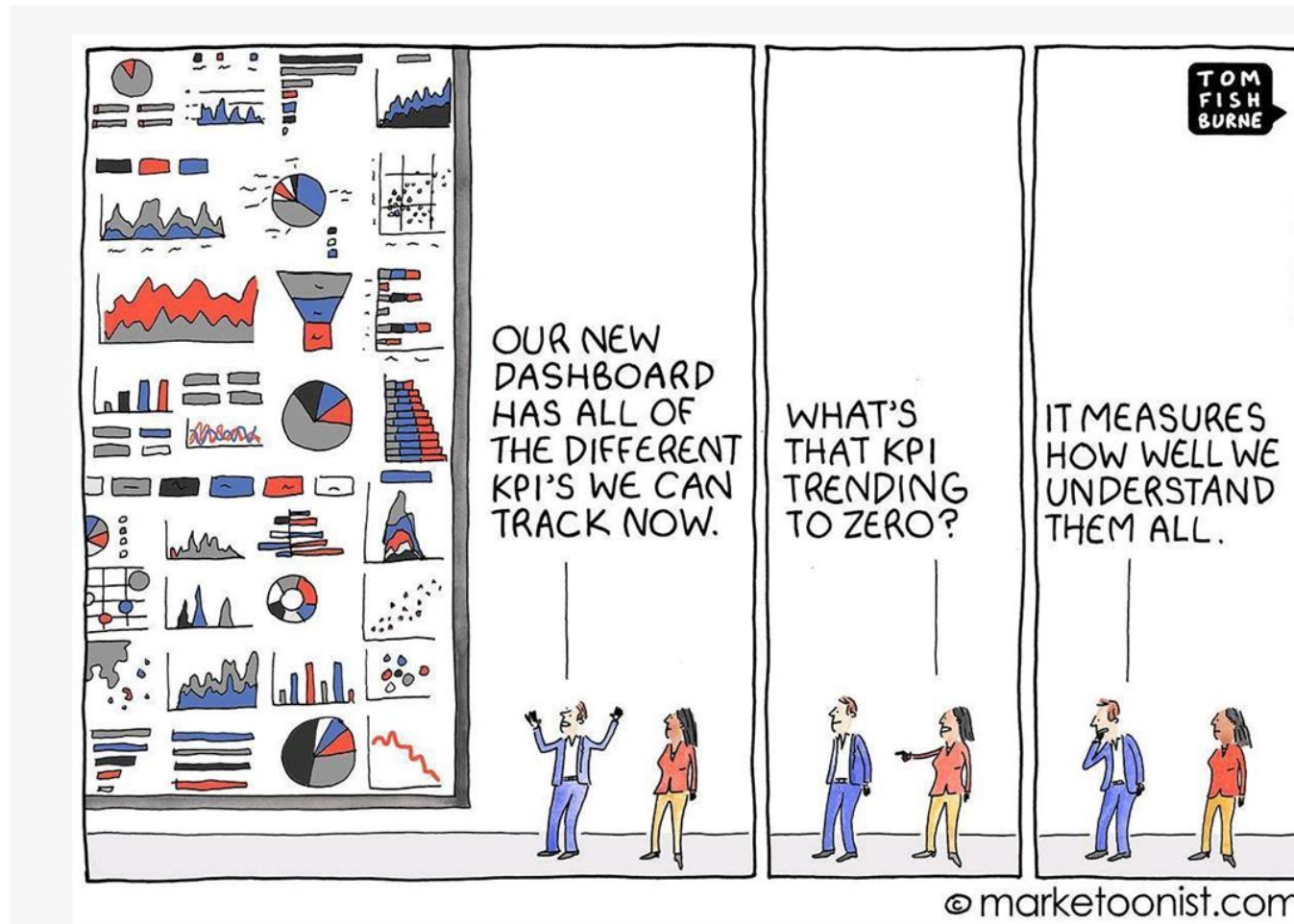
Requirement for drying of  
floor elements!

Sustainable construction 2017  
BRF Viva



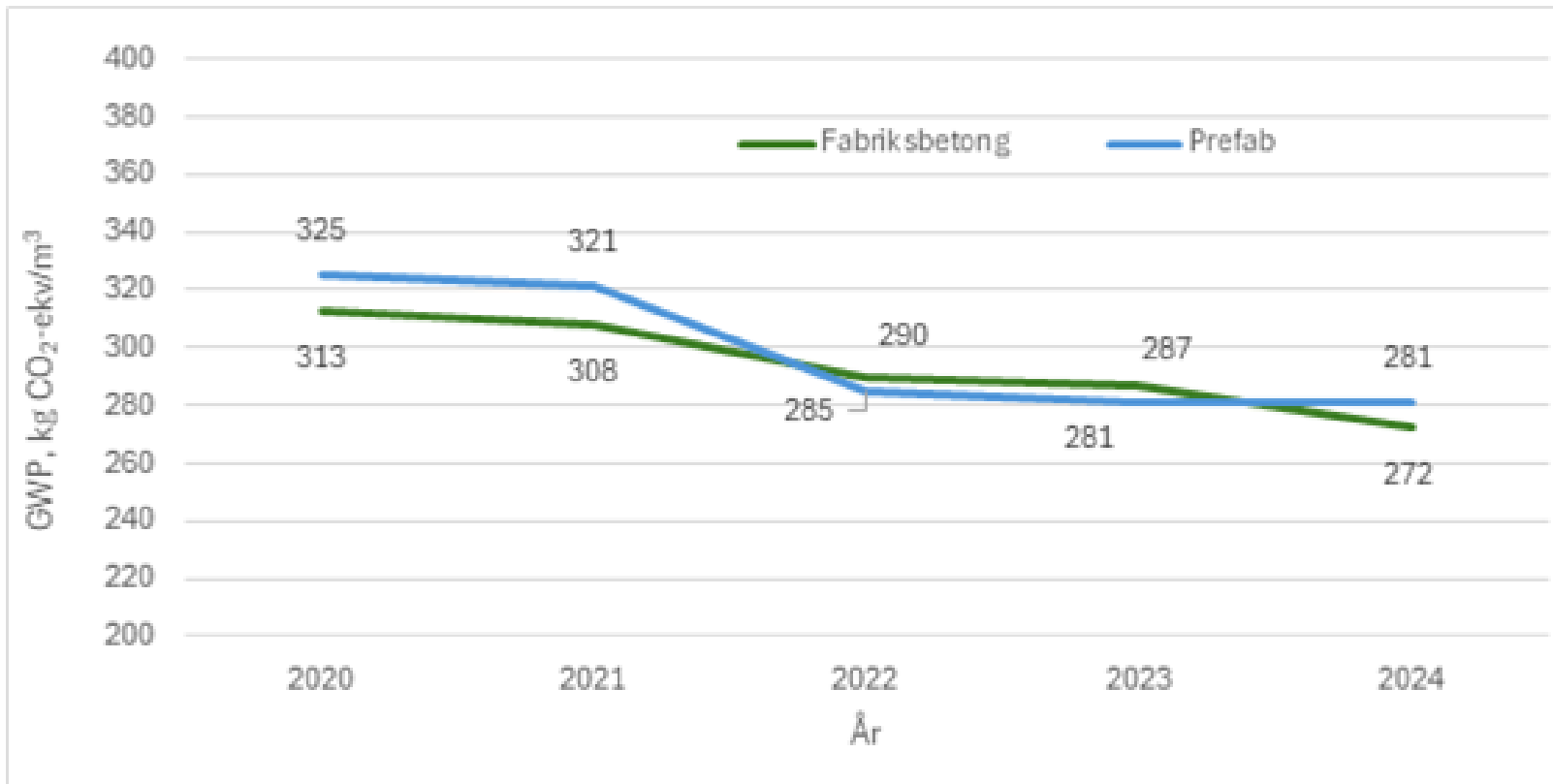
220-300 kg clinker/m<sup>3</sup>

# Statistics for KPIs



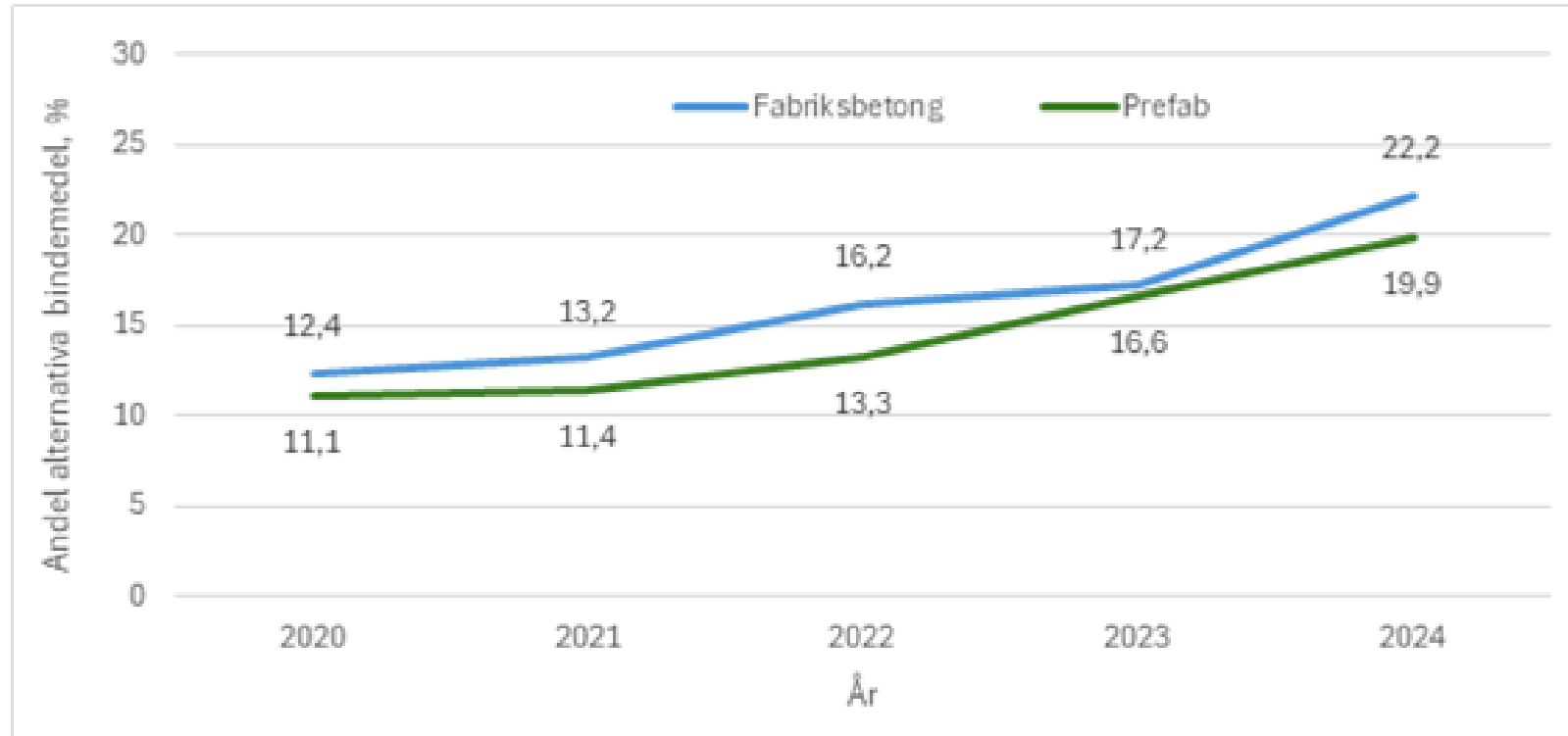
BETCRETE 3.0

# GWP – A1-A3 (no reinforcement)



BETCRETE 3.0

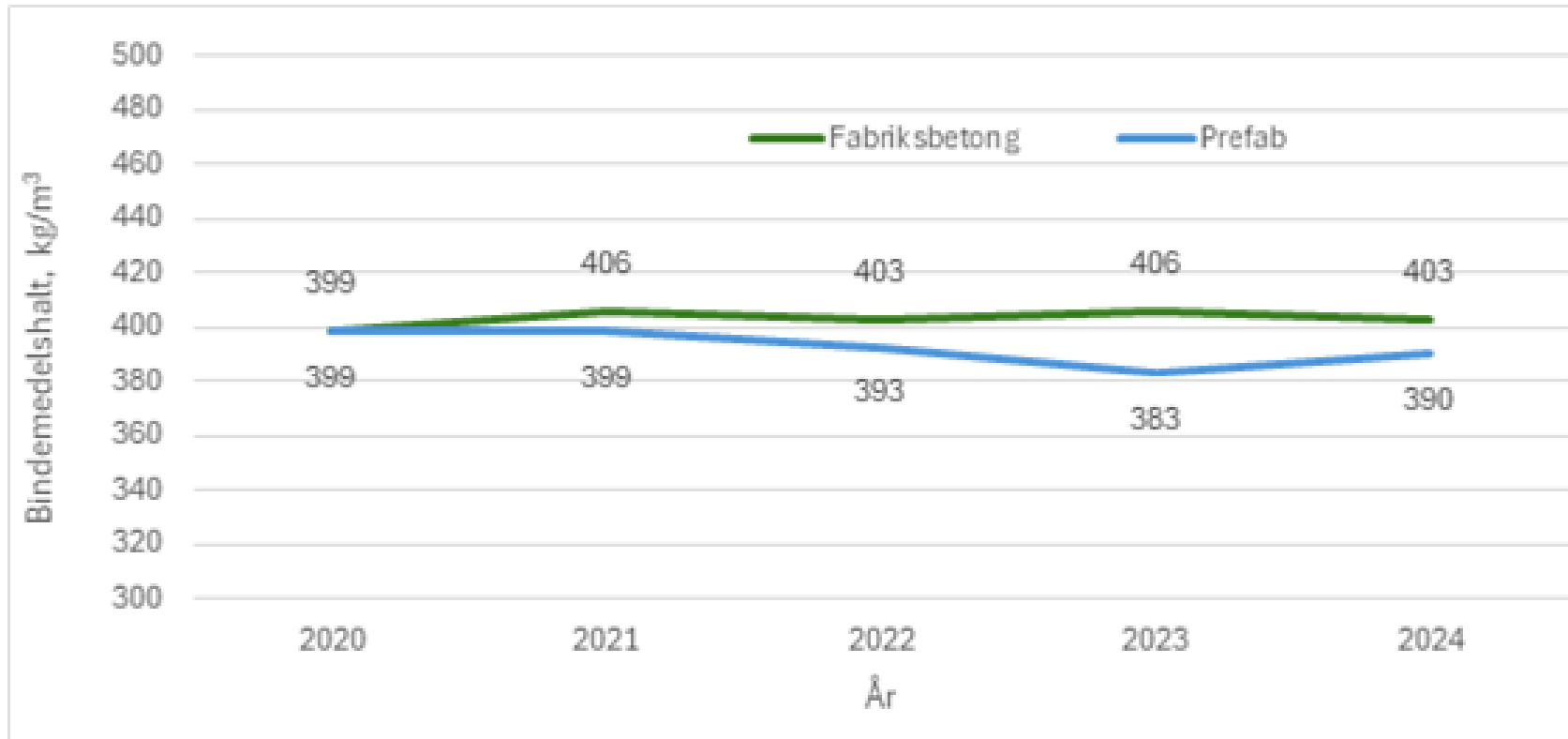
# Alternativ binders (%)





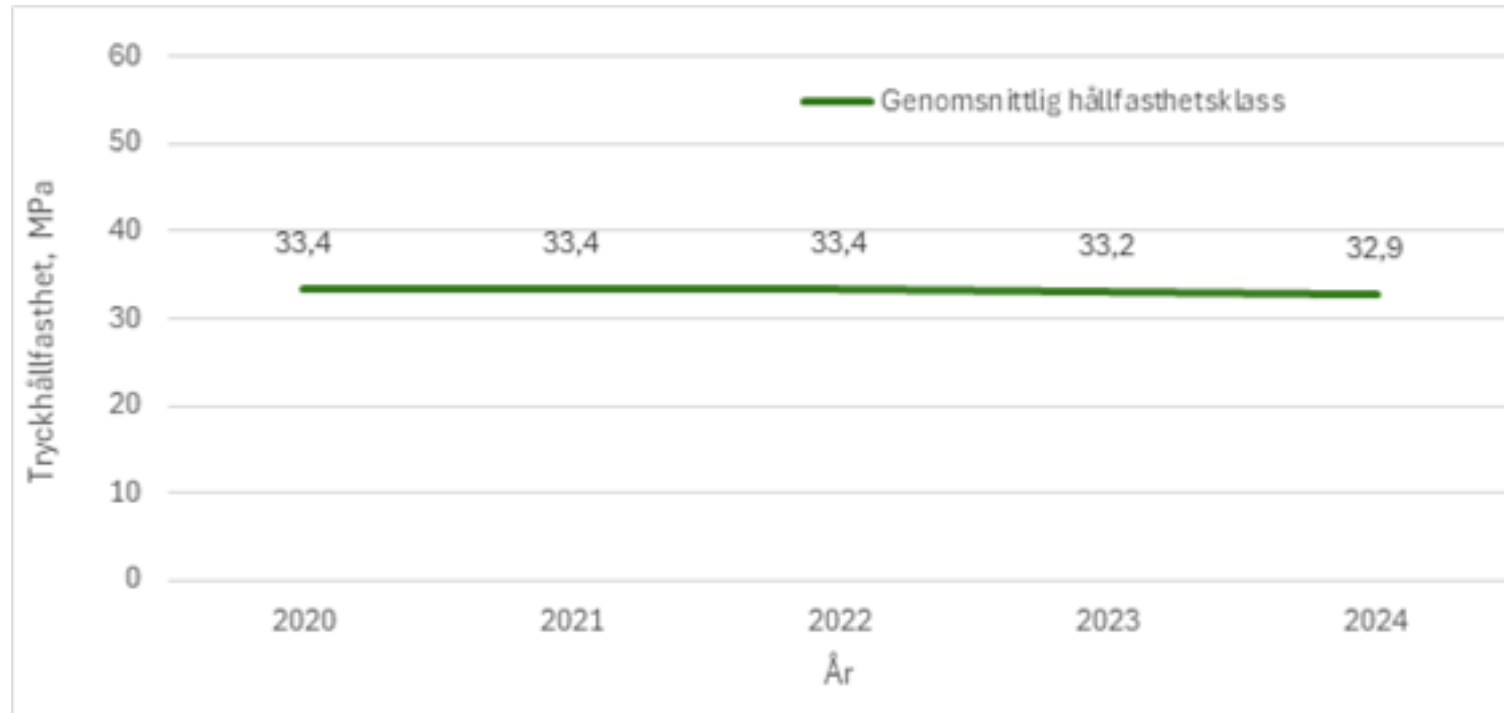
BETCRETE 3.0

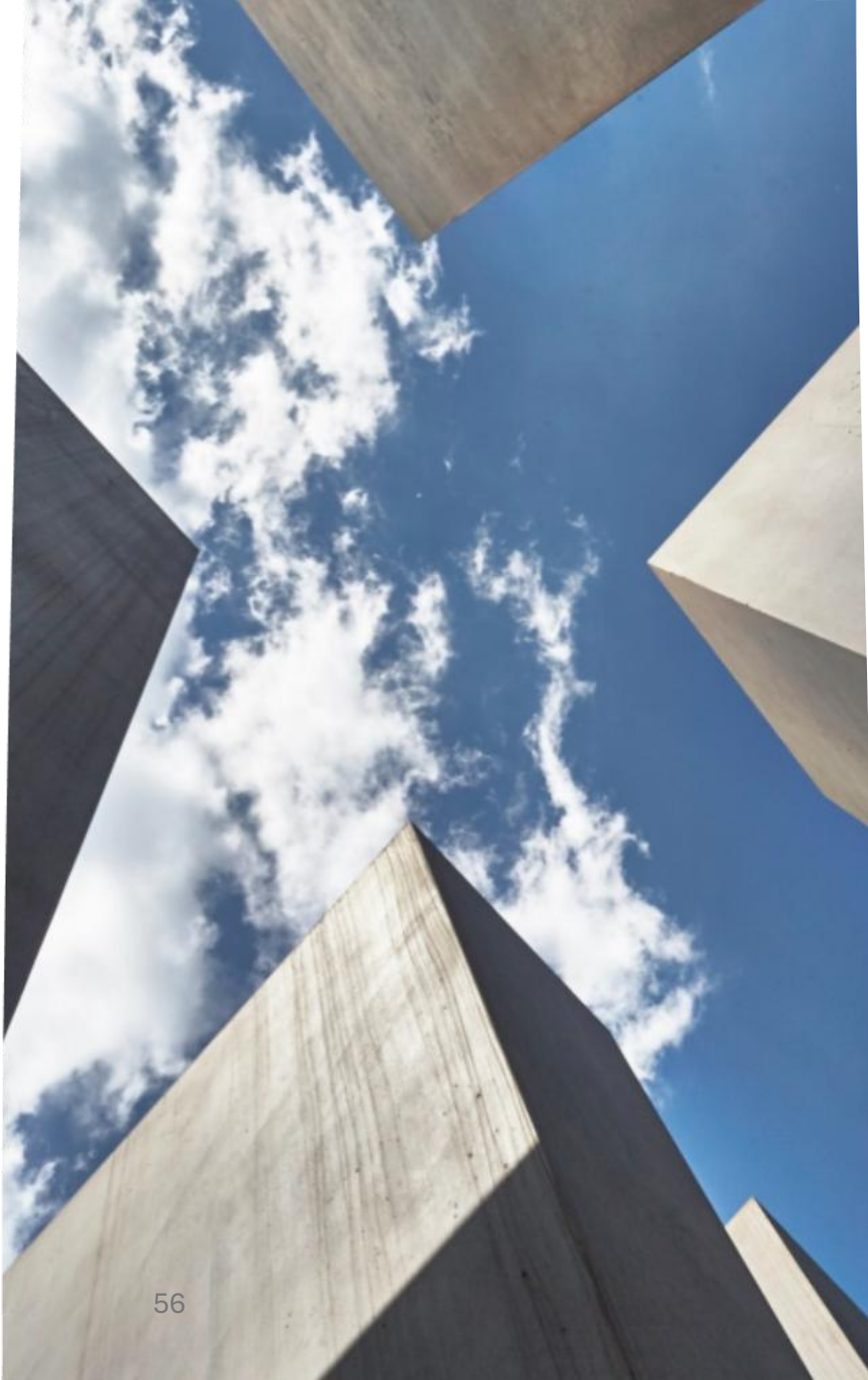
# Binder in kg/m<sup>3</sup>



BETCRETE 3.0

# Compressive strength (MPa)





# BETCRETE 3.0

## Innovations & Research Highlights

### **Industrial By-product Valorization**

Copper slag and other industrial by-products are used as supplementary cementitious materials to reduce cement use.

### **Low-Carbon Cement Alternatives**

Natural pozzolans formulations provide a sustainable alternative to traditional clinker-based cement.

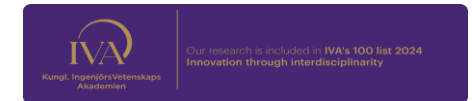
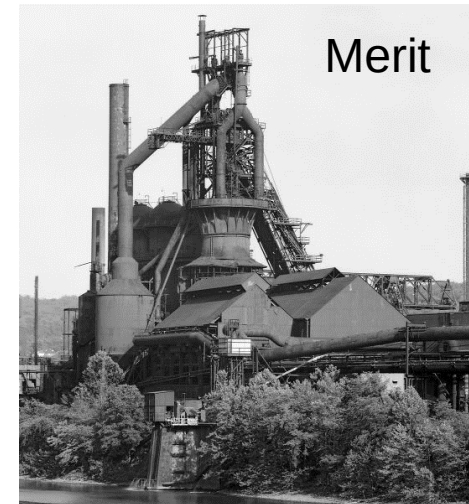
### **Circularity and Reuse Projects**

Reuse of prefabricated concrete elements reduces waste and supports circular economy in construction.

### **Carbonation and AI Technologies**

Accelerated carbonation and AI-driven predictive modeling improve material properties and durability assessments.

# BETCRETE 3.0 – alternative binders



*SS 137004 - new standard for use of natural puzzolana*

*SS 137007 - standard for use of artificial puzzolana (2026)*



# BETCRETE reports

[www.diva-portal.org](http://www.diva-portal.org)

RI  
SE

SAMHÄLLSBYGGNAD  
HÅLLBART BYGGANDE  
BETCRETE 3.0



## BETCRETE 3.0 - Alternativa bindemedel: utveckling, verifiering och tillämpning

Katarina Malaga, Stefan Sandelin, Urs Müller, Åke Roos, Emma Zhang, Alexander Åkerlund, Henrik Vinell, Thomas Blanksvärd, Henry Flisell, Markus Petersson, Ingemar Löfgren, Armin Taheri, Jan Suchorzewski, Sara-Olivia Blylod, Nadia Al-Ayish, Oskar Linderöth; Niklas Johansson

RISE Rapport 2025:47  
ISBN 978-91-90036-34-1

RI  
SE

SAMHÄLLSBYGGNAD  
HÅLLBART BYGGANDE  
BETCRETE 3.0



## BETCRETE 3.0 – Hållbarhetsindikator för cement och betong (2020 - 2024)

Katarina Malaga, Malin Löfsjögård, Staffan Carlström, Karin Gäbel, Erik Enecker, Lars-Erik Ericson, Ingemar Löfgren, Nils Kågström, Oskar Linderöth, Christopher Mörtzell, Janna Karlsson, Ulrika Åhlund, Benjamin Krutö, David Lindblad, Jonas Carlswärd, Mats Emborg, Stefan Östman, Johan Hedman, Erik Liljebj, Erik Månsson, Henrik Vinell, Thomas Blanksvärd

RISE rapport 2025:44  
ISBN 978-91-90036-31-0

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BETCRETE 3.0



## BETCRETE 3.0 - Betong med certifierad flygaska till dricksvattenanläggningar

Katarina Malaga, Elisabeth Helsing, Oskar Linderöth, Åsa Nilsson, Jenny Åström

RISE Rapport 2025:48  
ISBN: 978-91-90036-35-8

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SE

BUILT ENVIRONMENT  
INFRASTRUCTURE AND  
CONCRETE TECHNOLOGY



## Potential for use of activated clays in concrete in Sweden – Roadmap

Urs Mueller, Gilles Plusquellec, Katarina Malaga

RISE Report 2021:110

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BUILT ENVIRONMENT  
INFRASTRUCTURE AND  
CONCRETE TECHNOLOGY



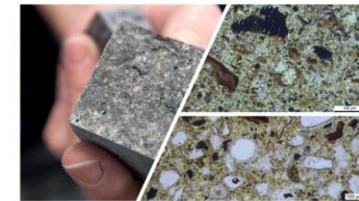
## Activated clays as supplementary cementitious material

Gilles Plusquellec, Arezou Babaahmadi, Emilie L'Hopital, Urs Mueller

RISE Report 2021:25

RI  
SE

BUILT ENVIRONMENT  
INFRASTRUCTURE AND  
CONCRETE TECHNOLOGY



## Biomass ash as supplementary cementitious materials: Characterization, application, and re-conditioning

Gilles Plusquellec, Emilie L'Hopital, Arezou Babaahmadi, Urs Mueller

RISE Report 2022:30



# Future Outlook and Conclusions

## CCS Facility Development

Sweden plans a CCS facility in Slite by 2030 to capture 1.8 million tons of CO<sub>2</sub> annually, advancing sustainability.

## Climate-Neutral Concrete Market

Climate-neutral concrete is anticipated between 2030-2035, enabled by CCS, CCU, and SCM technology advancements.

## Collaboration & Innovation

Cross-sector collaboration is vital to align standards, innovate, and ensure economic viability in sustainable construction.

## Strategic Integration

Integrating portfolio diversification, circularity, and carbon capture forms a unified strategy for sustainable growth.



Thank you for your attention



katarina.malaga@ri.se



Latvijas  
Betona  
Savienība

# Latvijas XXII Betona olimpiāde – 2025

## XXII Latvian Concrete Olympics – 2025

26-27<sup>th</sup> November, 2025

Latvijas Betona savienības sacensības  
**BETONA OLIMPIĀDE 2025**

## JAUNS NOLIKUMS



Sadarbībā ar



Latvijas  
Betona  
Savienība



*Prezentāciju sagatavoja:  
Presentation prepared by:*

Genādijs Šahmenko (RTU),

Tomasz Nowacki (STACHEMA  
Polska)





## 1. Concrete

- The lowest deviation from 85 MPa

### 1. Kategorija BETONS.

- Trīs paraugu sērijai tiek izrēķināta vidējā absolūtā novirze D no 85 MPa.

$D = (\text{abs}(X_1 - 85) + \text{abs}(X_2 - 85) + \text{abs}(X_3 - 85)) / 3$ ,  
Šeit  $X_1$ ,  $X_2$ ,  $X_3$  – katra parauga spiedes stiprības rezultāti (MPa).

**18 x 3 = 54  
samples**

**A total of 99 samples  
were tested**



## 2. Light-weight concrete

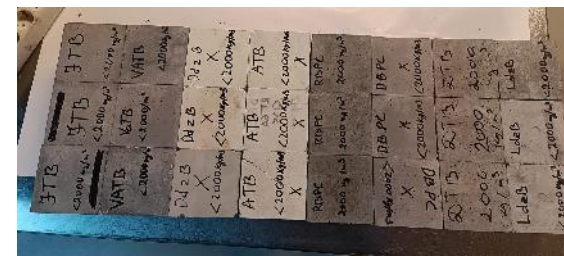
- Density < 2000 kg/m<sup>3</sup>
- The highest compressive strength

### 2. VIEGLBETONS.

- Trīs paraugu sērijai tiek izrēķināts: vidējais stiprības rezultāts  $X_{av}$  (MPa);
- Nevienam no 3 paraugiem blīvums sausā stāvoklī nedrīkst būt lielāks par 2000 kg/m<sup>3</sup>.

**15 x 3 = 45  
samples**

## DAĽŠNIEKI



# Latvijas Betona olimpiāde 2025

## ŽŪRIJAS KOMANDA

*Eduards Protasevičs*

*Andrejs Krasņikovs*

*Ģirts Koļendo*

*Pauls Ārgalis*

*Egīls Zvejnieks*

*Genādijs Šahmenko*

*Paldies visiem RTU*

*studentiem, kas*

*palīdzēja:*

*Anda Brauna*

*un citi*







Latvijas  
Betona  
Savienība

Betona olimpiādes atbalstītājs – Stachema Polska

Supporter of the Concrete Olympiad - Stachema Polska

Kopš 2018. gada STACHEMA Polska ir Latvijas Betona savienības biedrs, kā arī jau vairākus gadus ir galvenais atbalstītājs Latvijas Betona olimpiādei, ko organizē Latvijas Betona savienība (LBS) sadarbībā ar Rīgas Tehnisko universitāti.

STACHEMA ir viens no vadošajiem betona piedevu ražotājiem, kas gadiem ilgi pierādījis sevi gan Polijas, gan starptautiskajos tirgos.



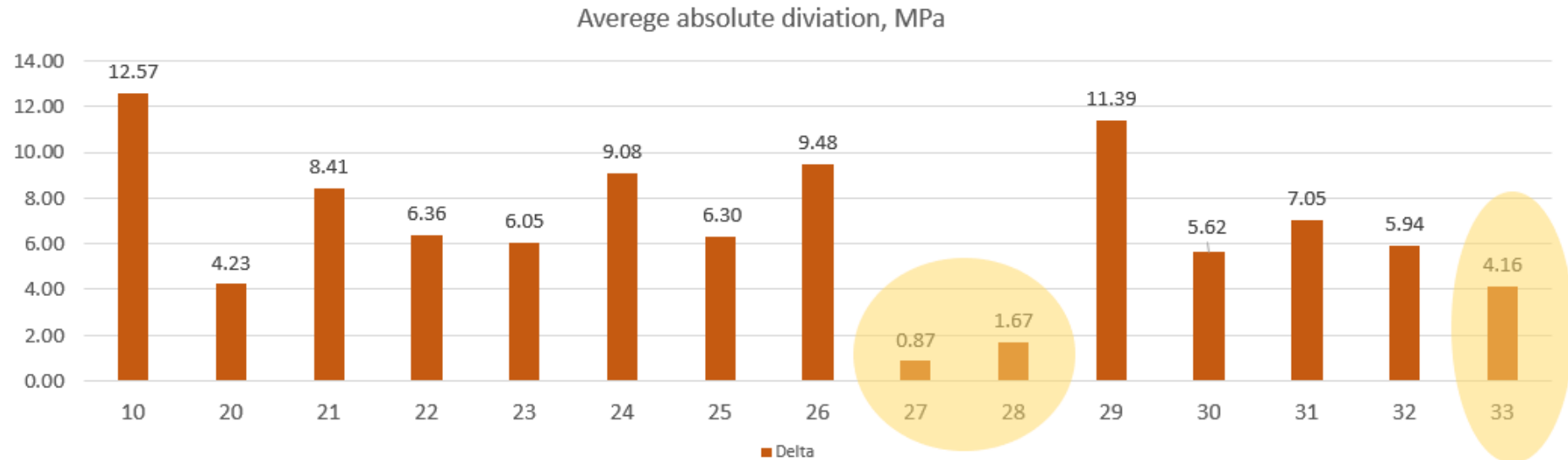
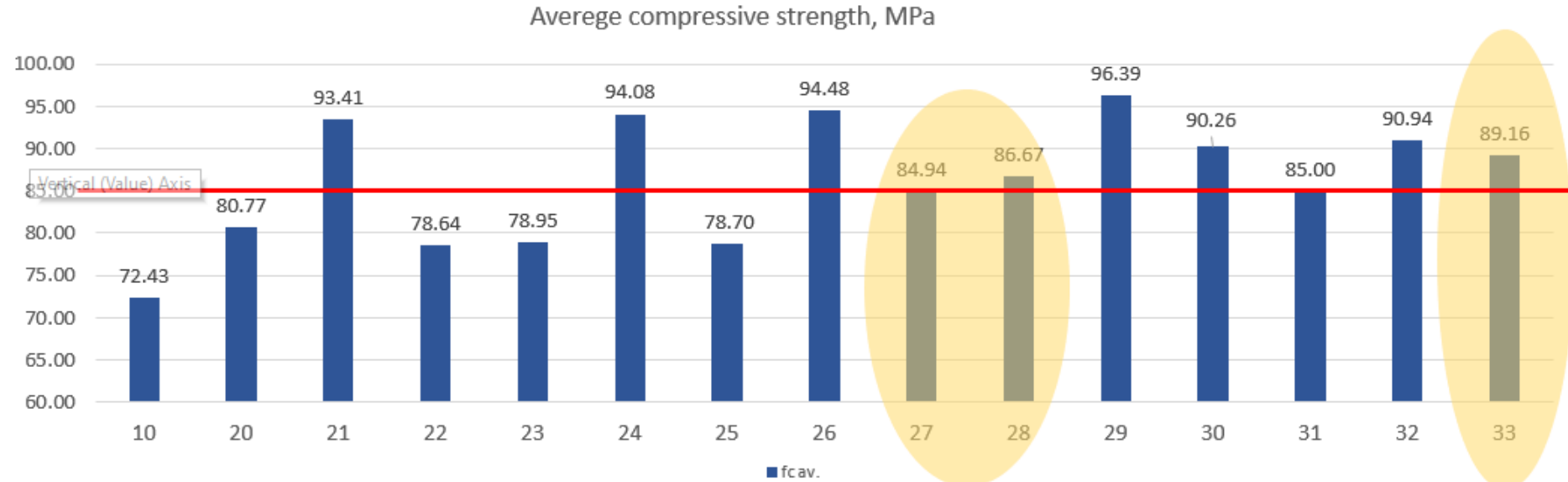
**Tomasz Nowacki (STACHEMA Polska, Vice-President )**

Pirmās trīs vietas katrā kategorijā saņems naudas balvas no Stachema Polska Sp z o.o. (1. vieta – 1000,- EUR; 2. vieta – 800,- EUR un 3. vieta – 600,- EUR).





# Results: Concrete (15 series x 3 samples)





Latvijas  
Betona  
Savienība

Betona olimpiādes atbalstītājs – Stachema Polska  
Supporter of the Concrete Olympiad - Stachema  
Polska

## Category: Concrete / Betons

$f_c$  av. = 84.94 MPa

**D = 0.87 MPa**

$f_c$  av. = 86.67 MPa

**D = 1.67 MPa**



SIA  
Koro  
Būve



SIA  
Daugavpil  
s Dzelzs-  
betons MB

$f_c$  av. = 89.16 MPa

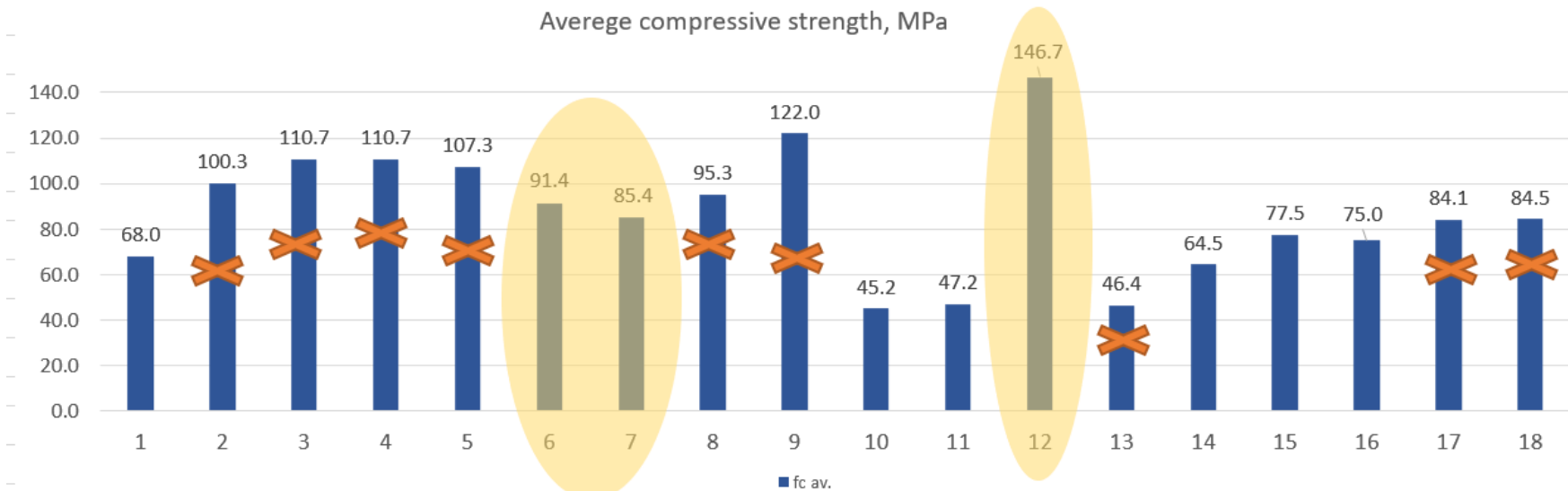
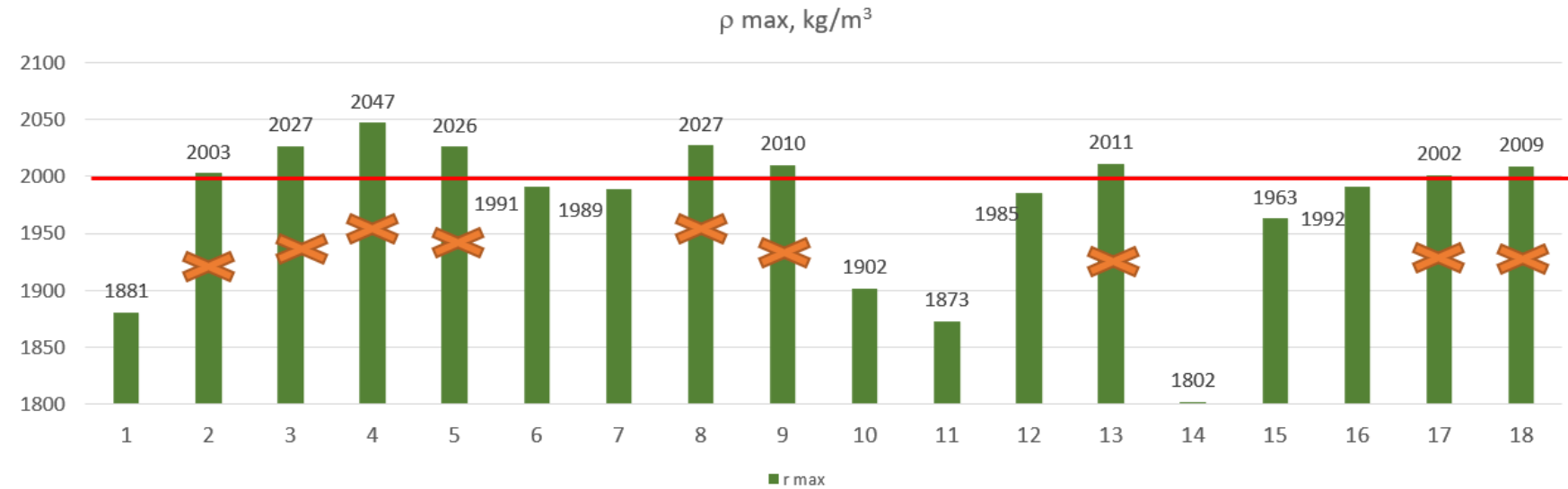
**D = 4.16 MPa**



Liepājas  
Dzelzs-  
betons  
MB



# Results: Light-weight concrete < 2000 kg/m<sup>3</sup> (18 series x 3 samples)



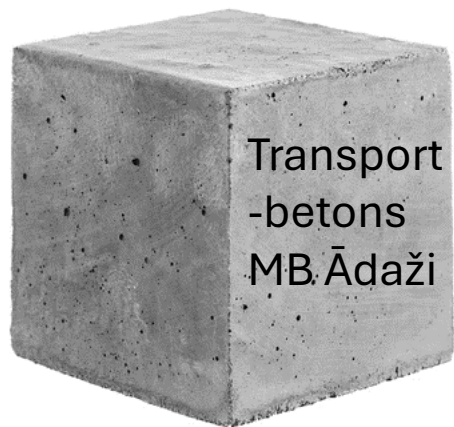


Latvijas  
Betona  
Savienība

Betona olimpiādes atbalstītājs – Stachema Polska  
Supporter of the Concrete Olympiad - Stachema  
Polska

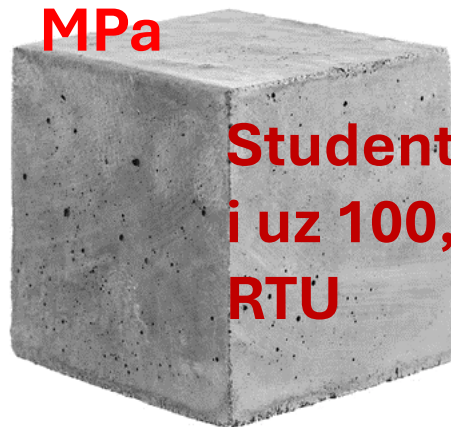
## Category: Light-weight concrete / Vieglbetons

$\rho_{\max} = 1991 \text{ kg/m}^3$   
 $f_c \text{ av.} = 91.4 \text{ MPa}$

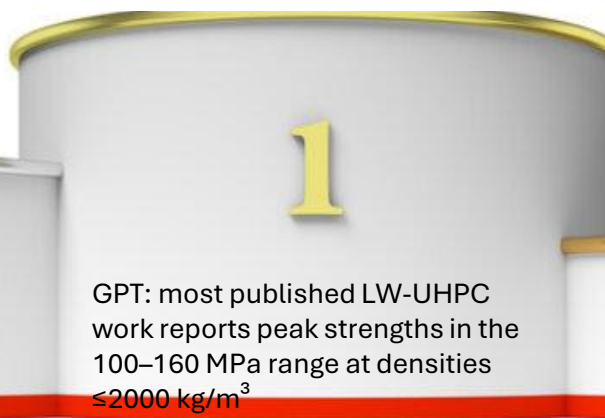


$\rho_{\max} = 1985 \text{ kg/m}^3$

$f_c \text{ av.} = 146,7$   
**MPa**



$\rho_{\max} = 1989 \text{ kg/m}^3$   
 $f_c \text{ av.} = 85.4$   
**MPa**

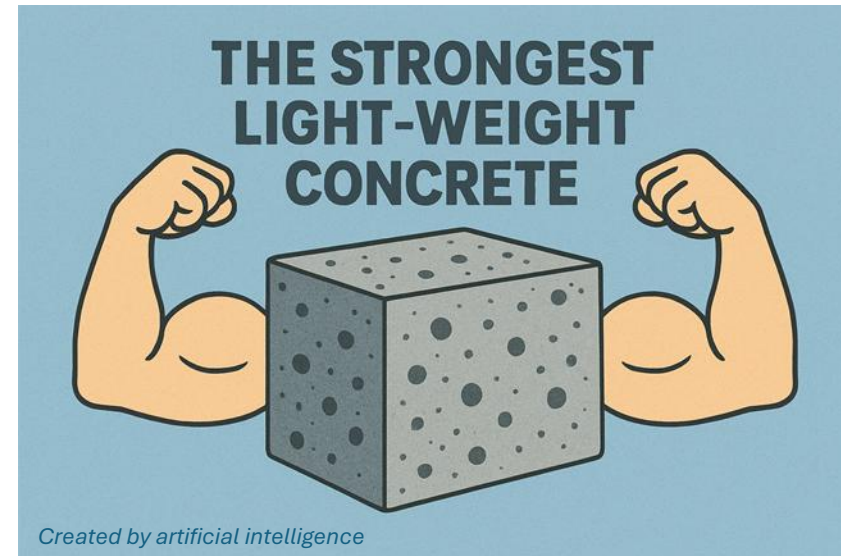
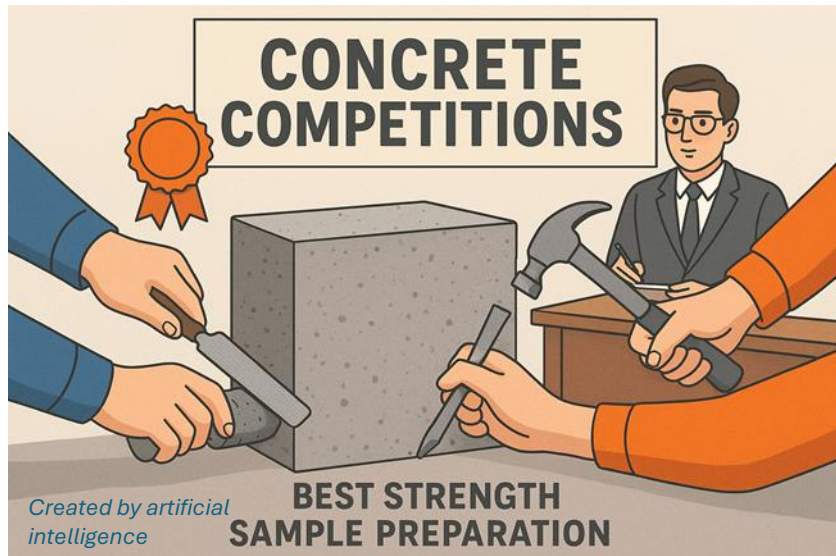






Gatavojamies 2026.  
gada olimpiādei !

Nolikums,  
Jaunie mērķi ?!







Heidelberg Materials



Carbon Capture

# A show off – or the future?

27/11/2025 | Brevik CCS | Latvia concrete day





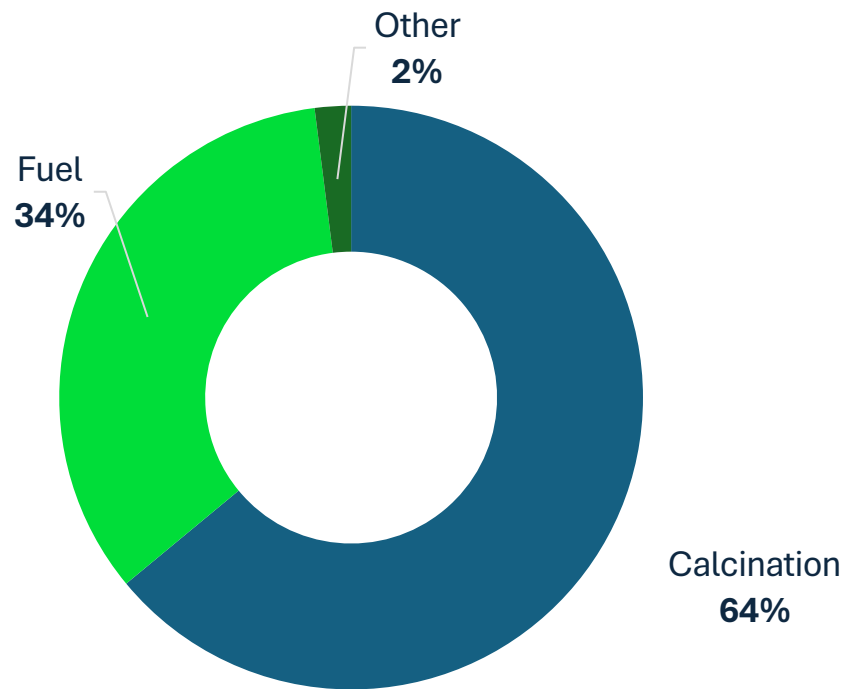




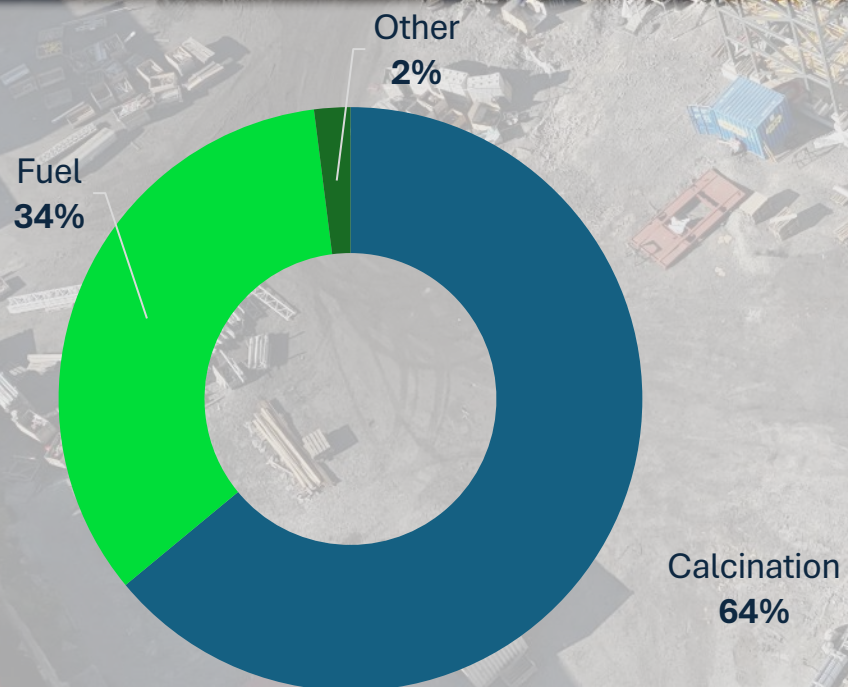




# Why cement production is CO<sub>2</sub>intense

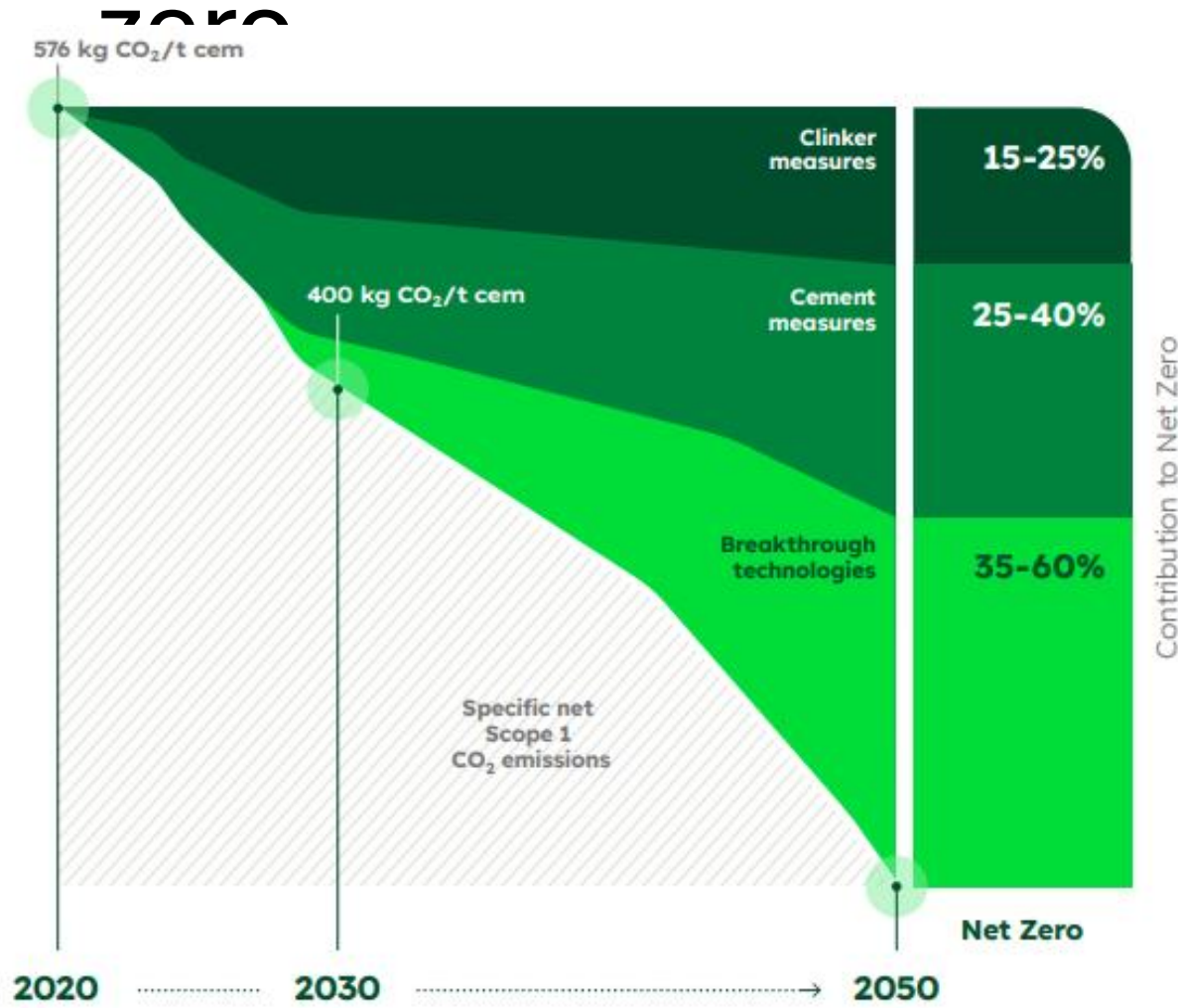








# We are pulling all levers on our path to net



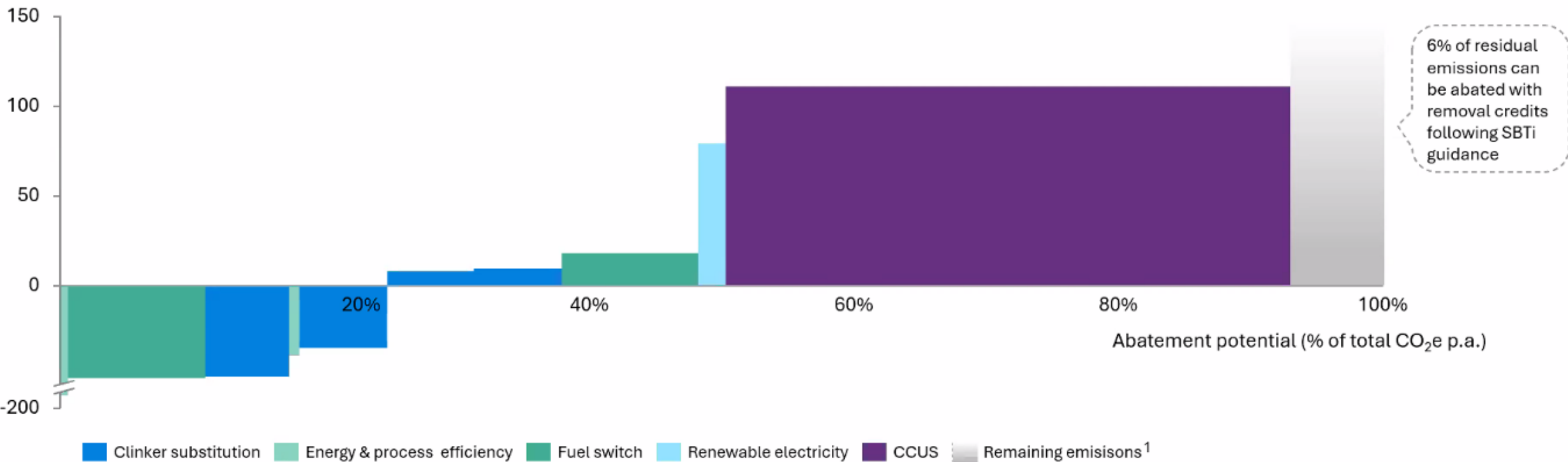
## Levers to reach our Net Zero target

- **Clinker Measures**
  - Increase efficiency of plants
  - >50% Alternative fuels rate
  - 20% Biomass fuels rate
- **Cement Measures**
  - Clinker incorporation: <64%
  - Drive circularity
- **Breakthrough technologies**
  - New technologies, such as CCUS

# Carbon capture is the biggest lever for cutting emissions in cement

## Marginal abatement cost for global cement industry shows the high costs linked to deep decarbonization

Abatement costs for complete decarbonization of the sector, scope 1 and 2 emissions (\$/t CO<sub>2</sub>e)



1. Residuals emissions coming from uncaptured emissions and upstream emissions associated with feedstock | Note 1: Marginal abatement cost depends on the company maturity and starting point in the decarbonization journey; Note 2: Based on the US market as of November 2024 | Sources: Enerdata, IEA, WoodMac, Cembureau; EC JRC; ECRA Technology Papers; MPP; BCG Net Zero Explorer

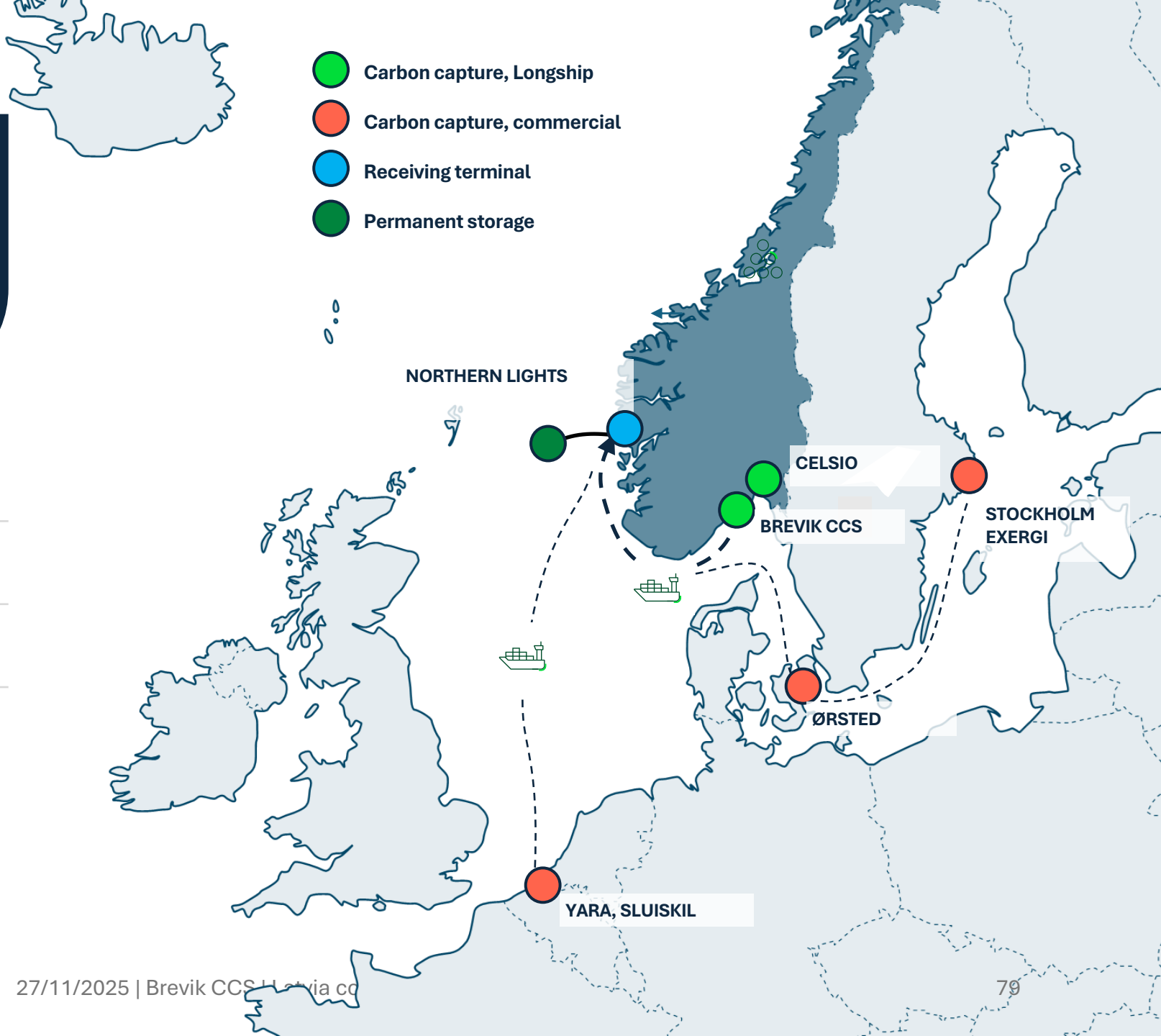
# The Longship project

**01** | Carbon capture from **industrial sources incl.** Brevik cement plant, Heidelberg Materials

**02** | Transport to Øygarden, Northern Lights

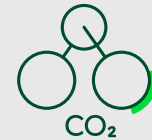
**03** | Pipeline to storage in North Sea, Northern Lights

**Supported by state funding** for installation and 10 years operation

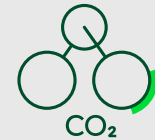




# Brevik CCS: The world's first and only industrial-scale carbon capture facility in a cement plant



**400,000 tonnes**  
of CO<sub>2</sub> per year



**55 tonnes**  
of CO<sub>2</sub> per hour

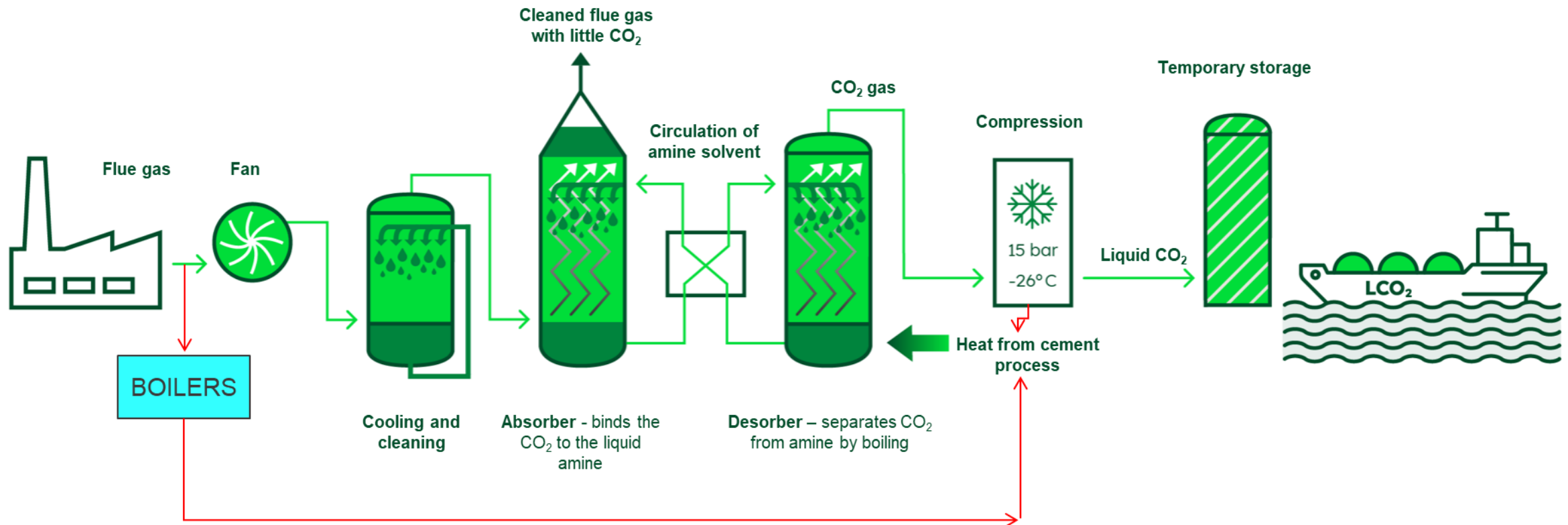


Capturing **50% of the plant's CO<sub>2</sub> emissions** – limited by **available waste heat**

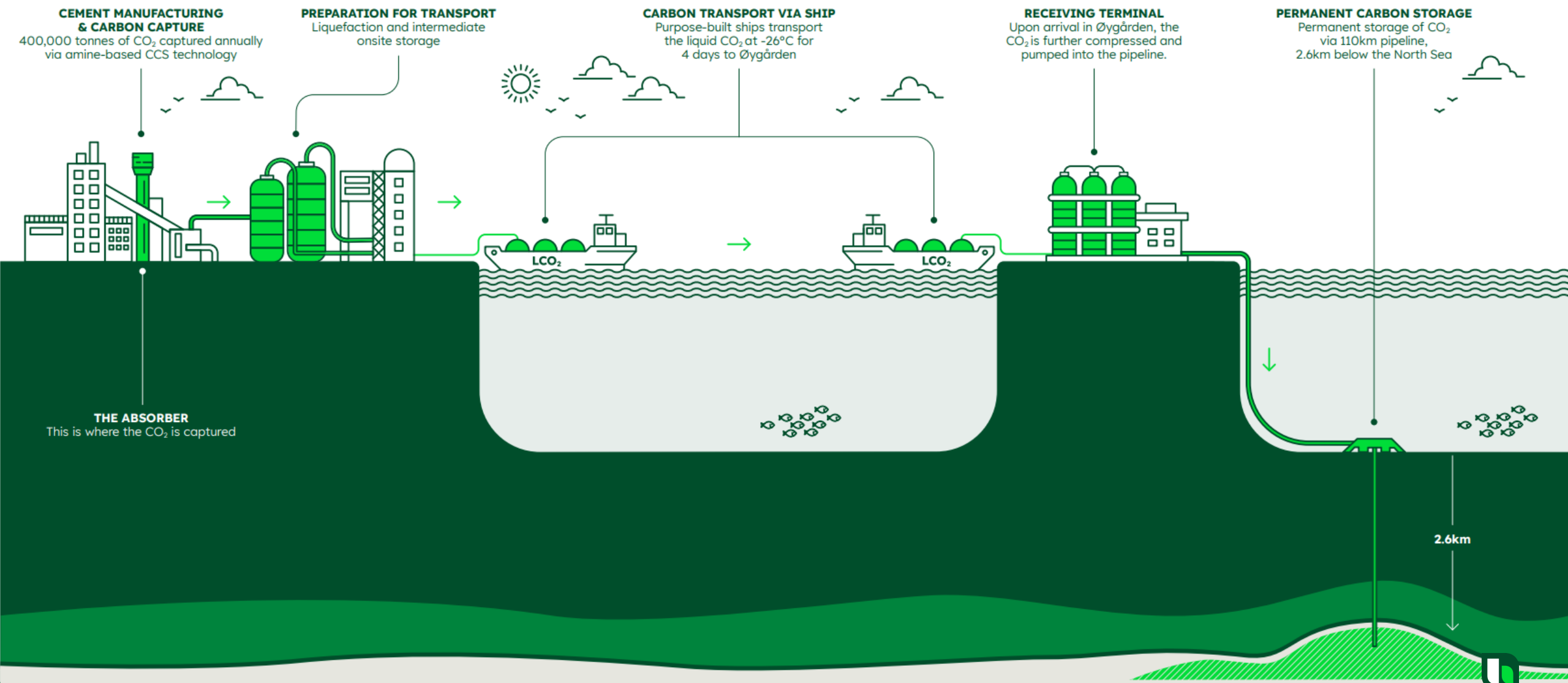


**46 MW** waste heat recovery – **ca 30 MW** from cement kiln, **16 MW** from **CO<sub>2</sub> compressor**

## How to catch the carbon dioxide – and store it



# From capture to storage





## Milestones in the Brevik CCS project

- 1. December 2024: Mechanical completion
- 12. February 2025: First CO<sub>2</sub>-capture
- 5. May 2025: First liquefaction of CO<sub>2</sub>
- 9. May 2025: 1000 tons of CO<sub>2</sub> captured
- 28. August 2025. First CO<sub>2</sub> confirmed stored at Northern Light.
- 15. September 2025: First P-EPD for CCS published
- 17. October 2025: The world's first evoZero cement was delivered and the first pour of concrete with evoZero cement was made





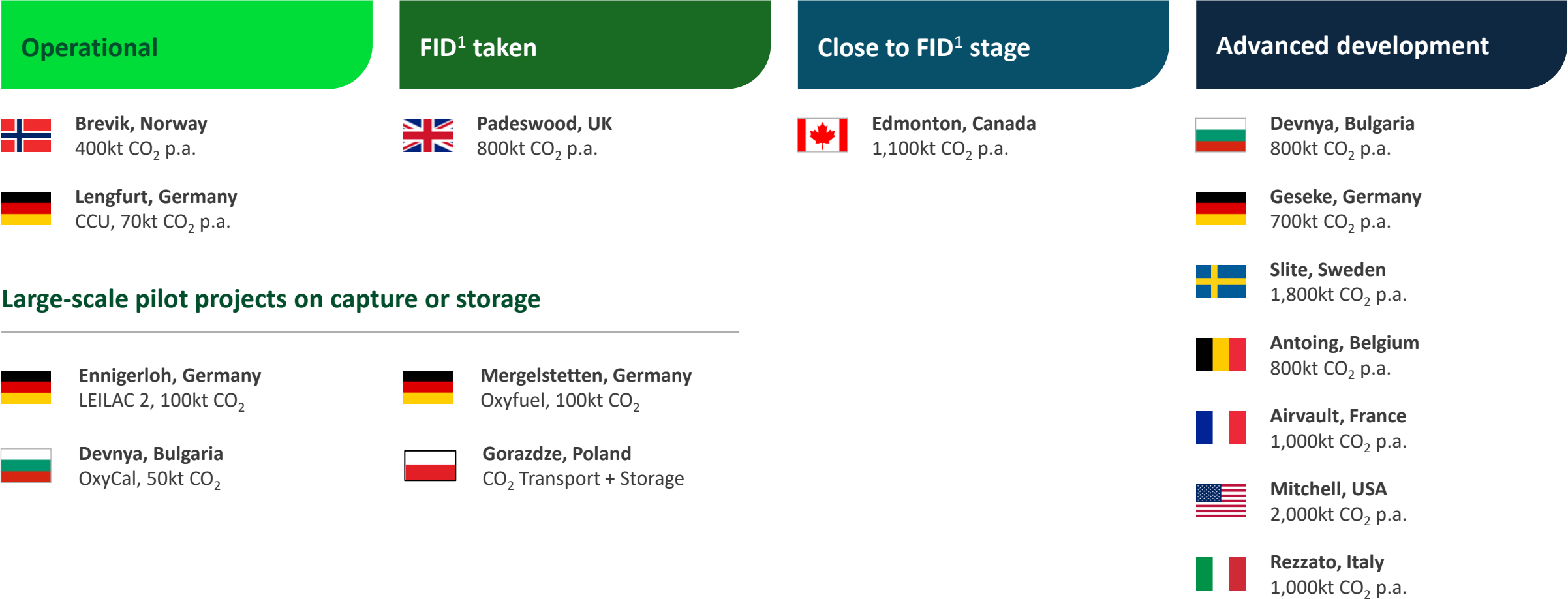
## Skøyen Station Norway

One of the very first deliveries of evoZero supports the construction of the new Skøyen Station in Oslo, Norway, constructed by Skanska.





# We have the most advanced CCUS project portfolio – driving global advantage



<sup>1</sup> Final investment decision



## Supporting framework needed for a successful rollout of CCUS



A **broad exchange between industry leaders, scientists, and policy makers** is required to ensure an environment that enables industry transformation.

To accelerate CCUS project realization, we need:

- **CO<sub>2</sub> transport & storage infrastructure** to be in place
- **Carbon pricing schemes** with **revenues being re-invested** into decarbonisation of point sources
- **Lead market and procurement schemes** to promote low-carbon materials, incl. chain of custody models
- **Carbon removals** to be recognized in compliance markets

”

We are the first in the world offering  
cement products based on CCS:

**evozero**



# evoZero® deliveries begin across Europe

Heidelberg Materials launches evoZero®, the first near-zero carbon captured cement.

[Read the press release](#)







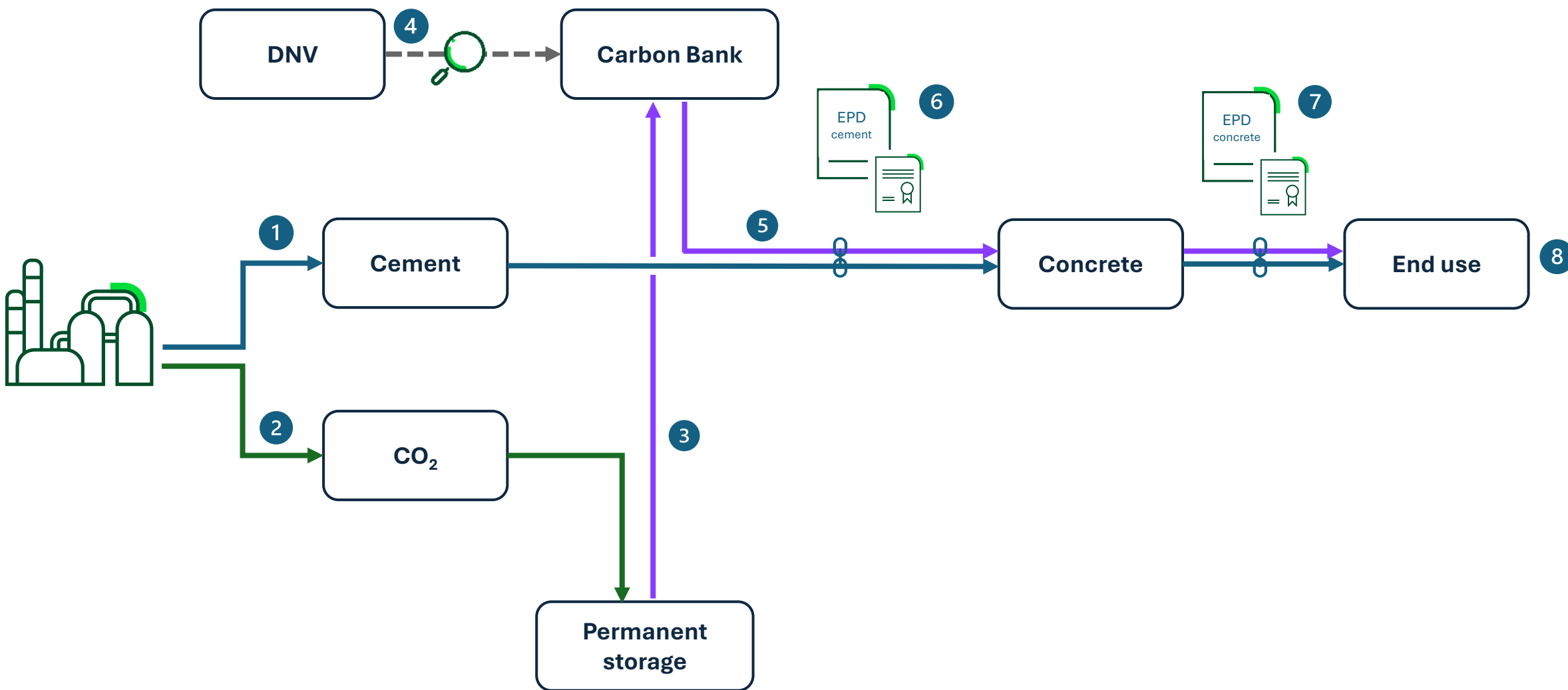
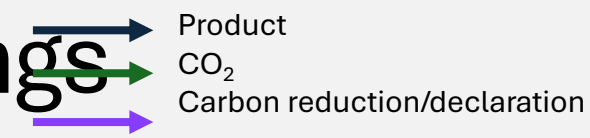
## Accurate and transparent CO<sub>2</sub> accounting

> Carbon bank storage

> Secured by blockchain-like technology

> Third-party verification

# The Carbon bank – keep track of the savings

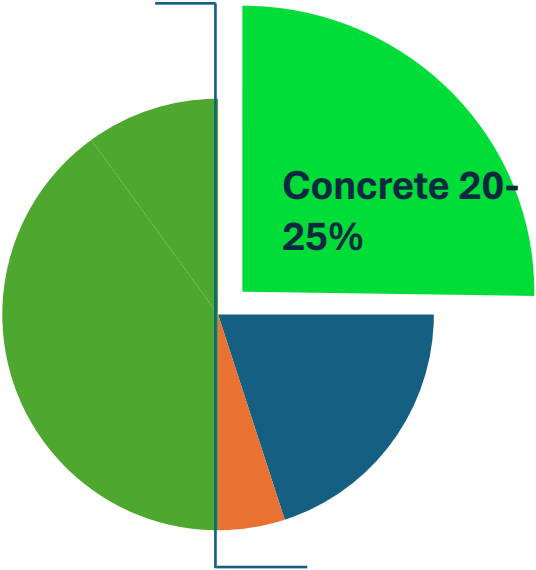


# evoZero: embodied carbon reduction – creating immediate customer value

## Building lifecycle carbon emissions

Illustrative example

Building operation & demolition



Building materials & construction



### Customer value creation

- > Better loan terms
- > Reach carbon reduction targets
- > Green occupancy premium
- > Green rent or sales premium



# Thank You.





Heidelberg  
Materials

# DECARBONIZATION OF THE LATVIAN CEMENT

Krišjānis Lejnieks

Products & Process Technology manager

27/11/25

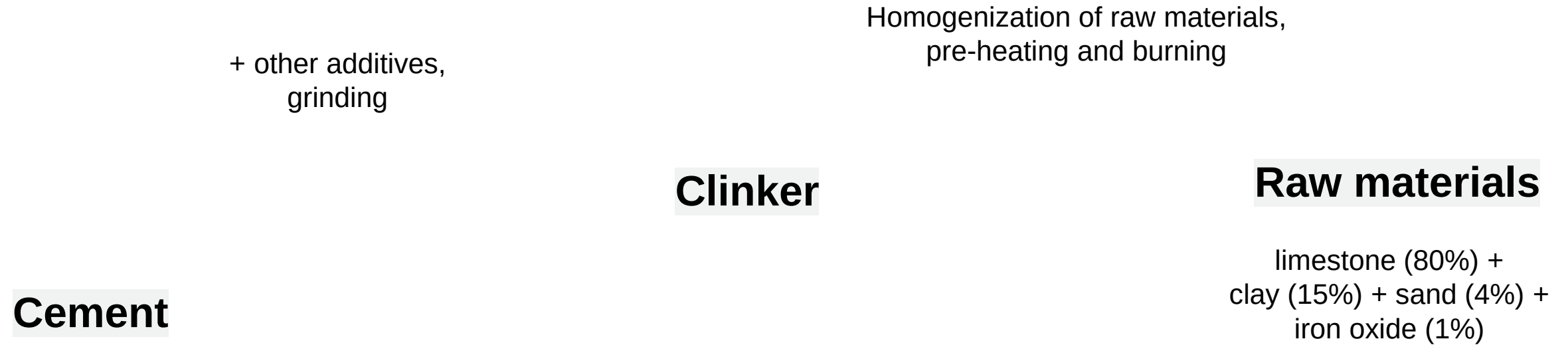
**SUSTAINABILITY THAT WORKS.**



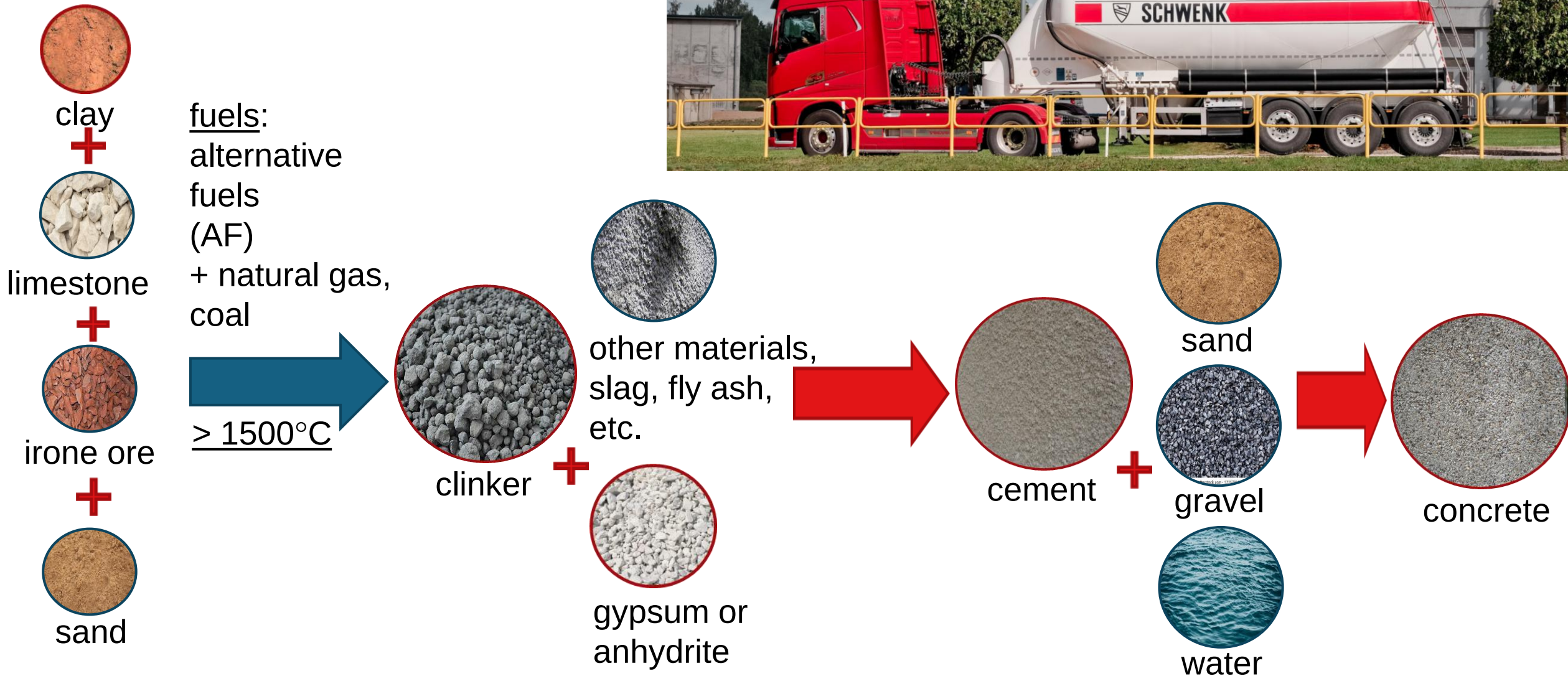
**SCHWENK**



# CEMENT PRODUCTION PROCESS



# PRODUCTION OF CEMENT AND CONCRETE



## CLINKER

Core component of cement. Produced by burning mixture of limestone, clay, sand and iron oxide in the high temperature kiln.



# EMISSIONS IN CEMENT PRODUCTION

WHERE DOES CO<sub>2</sub> ORIGINATE IN OUR PRODUCTION PROCESS?

## FUEL DETERMINED EMISSIONS

Emerge through use of fossil and alternative fuels in rotary kiln.

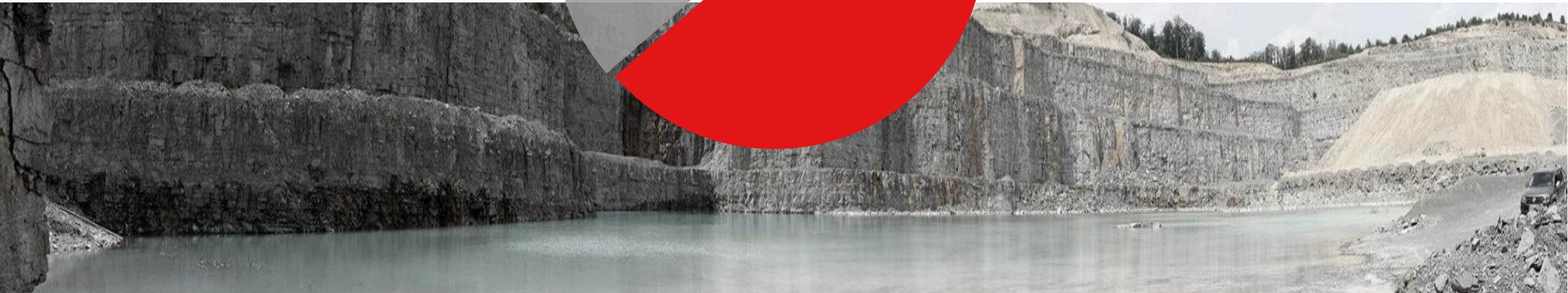
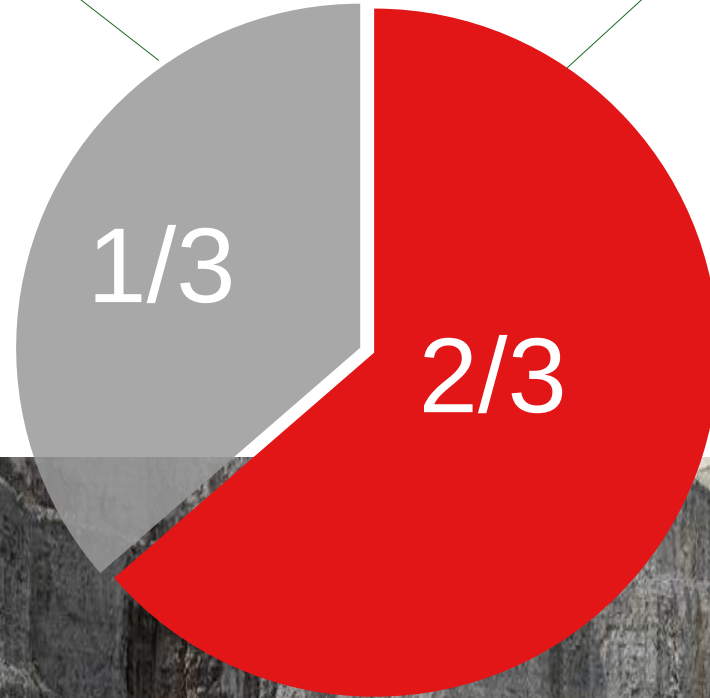
**The further reduction of these emissions is our first priority.**



## RAW MATERIAL DETERMINED EMISSIONS

Bound in limestone and are released in burning processes

**The possibility to reduce these emissions is rather limited.**



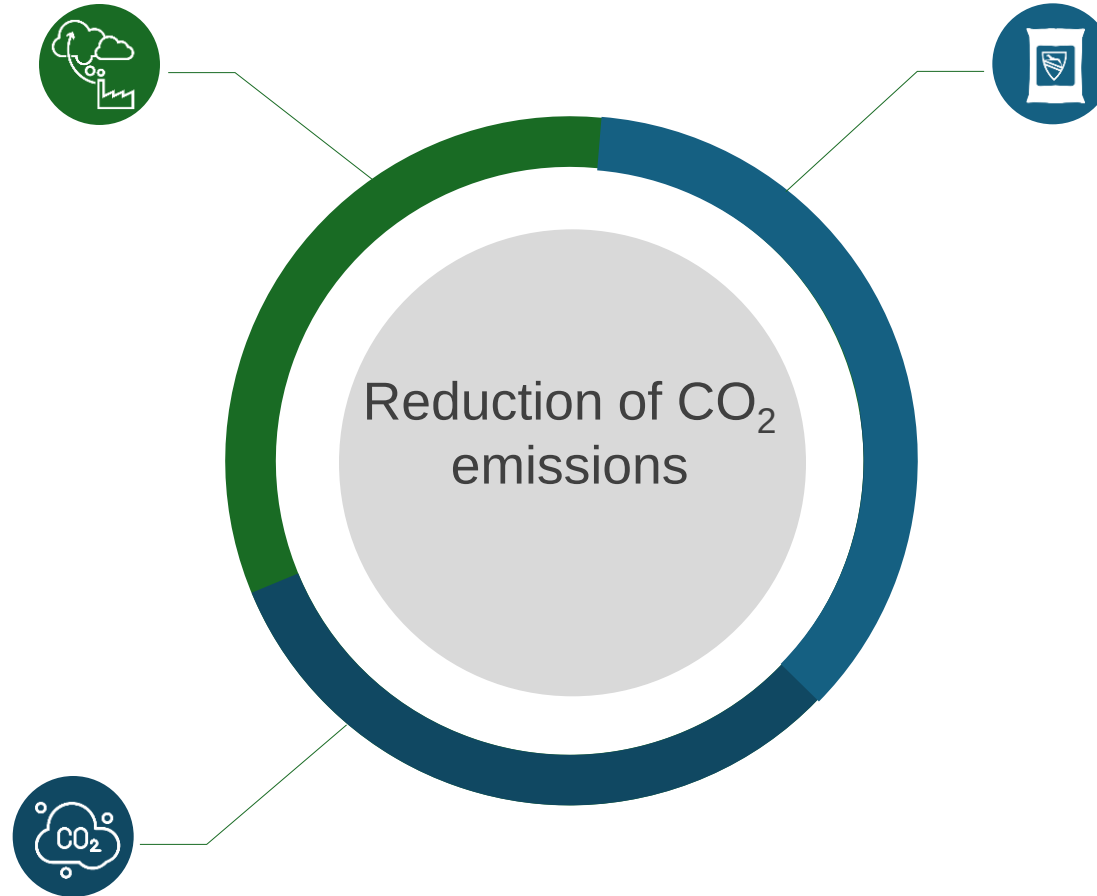
# GOALS FOR REDUCING CO<sub>2</sub> EMISSIONS IN BROCENI PLANT

## GOAL 1

- ✓ Reduce the CO<sub>2</sub> emission factor of the clinker by 50 kg/t CO<sub>2</sub> until 2025 compared to 2018
- Keep Alternative fuel rate close to 100%

## GOAL 3

By 2030 – the first CO<sub>2</sub> capturing plant in the group (Broceni) catching yearly 800.000 t CO<sub>2</sub>

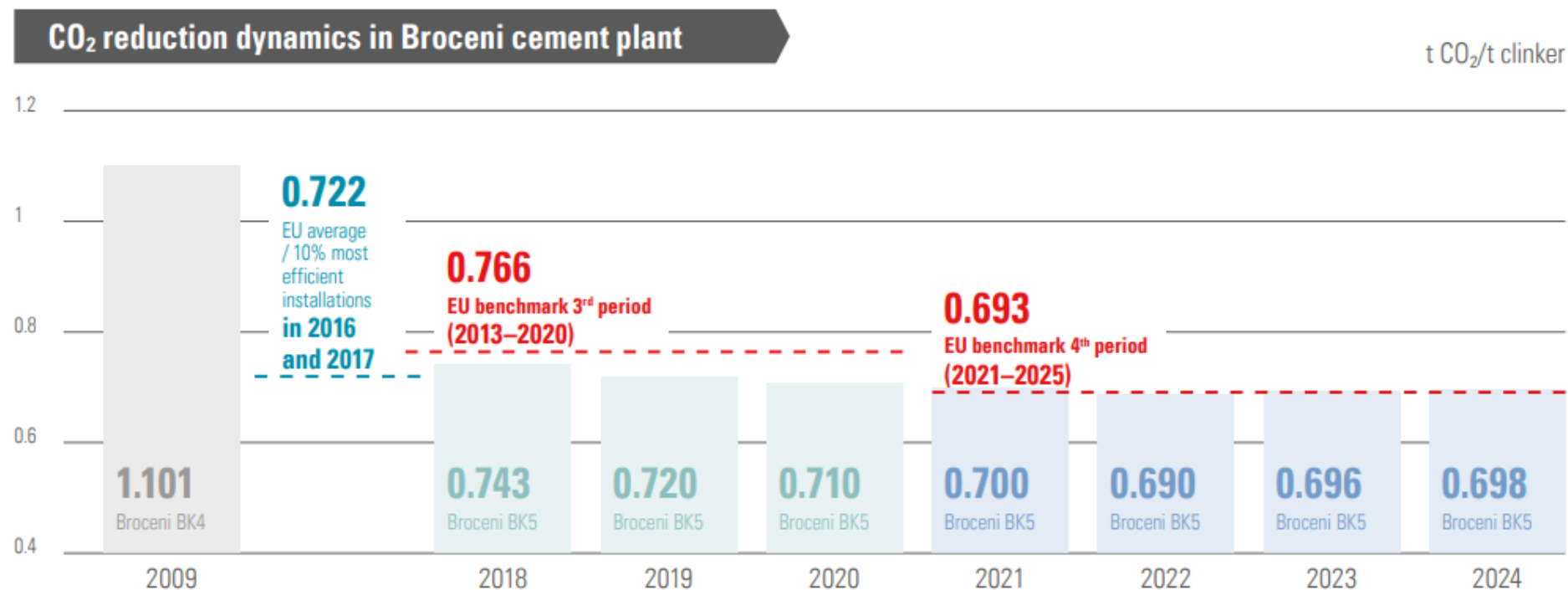


## GOAL 2

- ✓ Until 2025: Reduce the average clinker factor (% clinker in cement) by 10% compared to 2018
- Until 2030: reduce by another 15%

# GOAL 1 – REDUCE CO<sub>2</sub> EMISSIONS IN CLINKER PRODUCTION

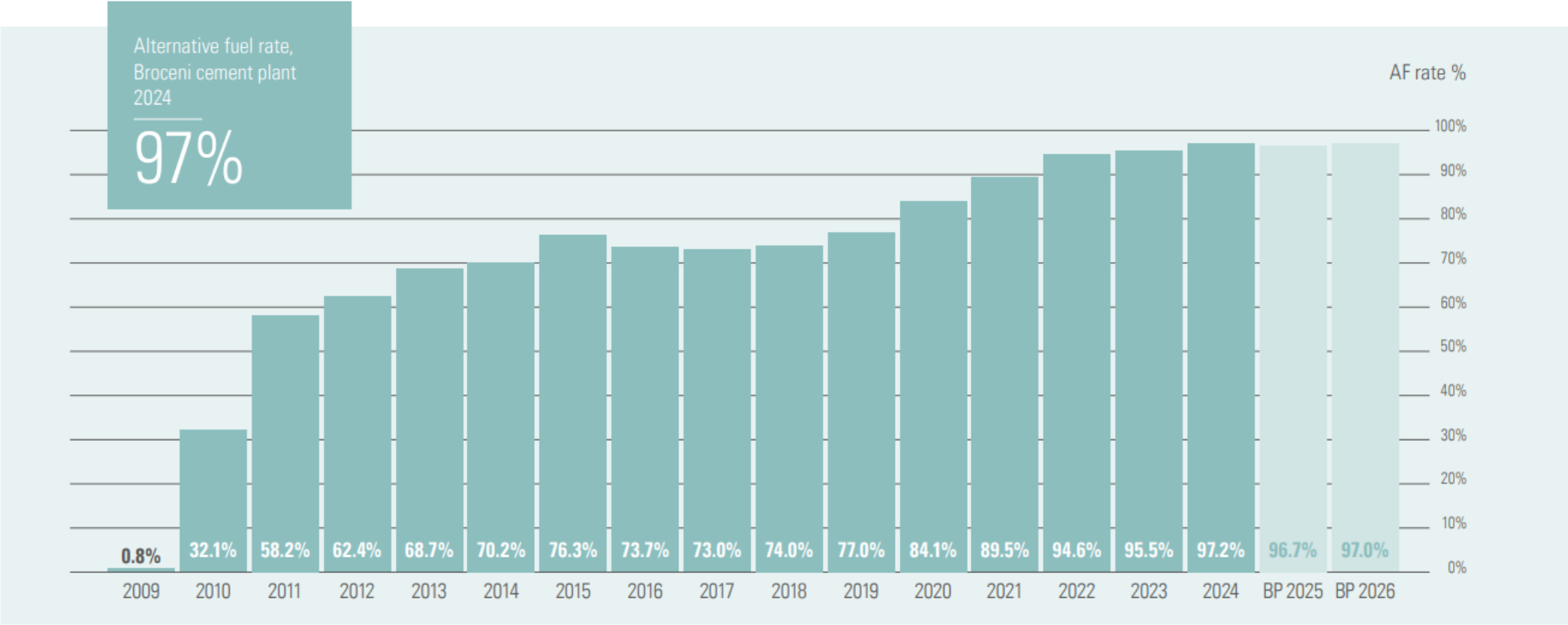
## CO<sub>2</sub> REDUCTION DYNAMICS 2009 - 2024





# GOAL 1 – REDUCE CO2 EMISSIONS IN CLINKER PRODUCTION

## ALTERNATIVE FULE RATE IN BROCENI CEMENT PLANT



# TYPES OF ALTERNATIVE FUEL IN BROCENI CEMENT PLANT



Solid recovered fuel  
(SRF)



Chipped tires



Tire fluff



NPS  
(neutralized polluted  
soil)

## GOAL 2 – CLINKER FACTOR REDUCTION IN CEMENT

### SUPPLEMENTARY CEMENTITIOUS MATERIALS IN SCHWENK GROUP

The use of SCMs is highly affected by their availability in the region, impact on cement and concrete properties

SCMs currently used in Latvia – limestone, opoka (pozzolan), slag.



Limestone flour



Slag



Oil shale ash



Natural pozzolan



# GOAL 2 – CLINKER FACTOR REDUCTION IN CEMENT PRODUCT EPD



## Environmental product declaration

in accordance with ISO 14025 and EN 15804+A2

CEM II/B-M (S-LL) 52.5 N (Viridiscement)



Owner of the declaration:  
SCHWENK Sverige AB

Product:  
CEM II/B-M (S-LL) 52.5 N  
(Viridiscement)

Declared unit:  
1 tonne

This declaration is based on Product  
Category Rules:  
CEN Standard EN  
15804:2012+A2:2019 serves as core  
PCR  
EN 16908:2017 Cement and building  
lime

The Norwegian EPD Foundation

Program operator:  
The Norwegian EPD  
Foundation

Declaration number:  
NEPD-11794-11729

Registration number:  
NEPD-11794-11729

Issue date:  
11.07.2025

Valid to:  
11.07.2030

EPD software:  
LCAno EPD generator ID:  
1114542

### Environmental impact Net

| Indicator           | Unit       | A1-A3    |
|---------------------|------------|----------|
| GWP-total, gross    | kg CO2 -eq | 5,24E+02 |
| GWP-fossil, gross   | kg CO2 -eq | 5,23E+02 |
| GWP-biogenic, gross | kg CO2 -eq | 6,78E-01 |
| GWP-luluc, gross    | kg CO2 -eq | 8,31E-02 |
| GWP-total, net      | kg CO2 -eq | 4,31E+02 |
| GWP-fossil, net     | kg CO2 -eq | 4,30E+02 |
| GWP-biogenic, net   | kg CO2 -eq | 6,78E-01 |
| GWP-luluc, net      | kg CO2 -eq | 8,31E-02 |
| CWRS                | kg CO2 -eq | 0,00E+00 |
| CWNRS               | kg CO2 -eq | 9,30E+01 |
| CC                  | kg CO2 -eq | 3,35E+02 |
| CCS                 | kg CO2     | 0,00E+00 |

GWP-total, gross = Global Warming Potential total, gross (GWP-fossil, gross + GWP-biogenic, gross + GWP-luluc); GWP-fossil, gross = Global Warming Potential fossil fuels, gross (Description according to EF 3.1); GWP-biogenic, gross = Global Warming Potential biogenic, gross (Description according to EF 3.1, in accordance with EN 16908, CF of carbon dioxide biogenic is 0); GWP-luluc = Global Warming Potential land use and land use change (Description according to EF 3.1); GWP-total, net = Global Warming Potential total, net (GWP-total, gross minus CWRS and CWNRS); CWRS = Emissions from combustion of waste from renewable sources (GWP from secondary fuels' combustion considering CH4 bio emissions); CWNRS = Emissions from combustion of waste from non-renewable sources (GWP from secondary fuels' combustion CO2 fossil, CO fossil, N2O and CH4 bio fossil); GWP-fossil, net = Global Warming Potential fossil fuels, net (GWP-fossil, gross minus CWNRS); GWP-biogenic, net = Global Warming Potential

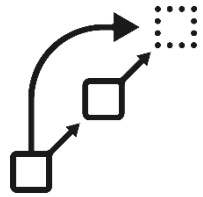
- GWP-total, gross **VS** GWP-total, net
- Electrical power for manufacturing – guarantees of origin

# GOAL 3 – FIRST DECARBONIZED CEMENT PLANT IN SCHWENK GROUP



---

Carbon capture (CC)



---

Carbon capture and storage (CCS)



---

Carbon capture and utilization (CCU)



# Thank you!

Krišjānis Lejnieks  
[krisjanis.lejnieks@schwenk.com](mailto:krisjanis.lejnieks@schwenk.com)

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[www.schwenk.de](http://www.schwenk.de)

 **SCHWENK**



# BROCĒNI CARBON CAPTURE PROJECT

Krists Mertens

CCS Project Director

27/11/25

**SUSTAINABILITY THAT WORKS.**



# WHY CARBON CAPTURE?

HEDGING AGAINST FUTURE RISKS

At a CO<sub>2</sub> price of 150 EUR/t, Brocēni cement plant will need 100M EUR/year to purchase CO<sub>2</sub> allowances in 2034.

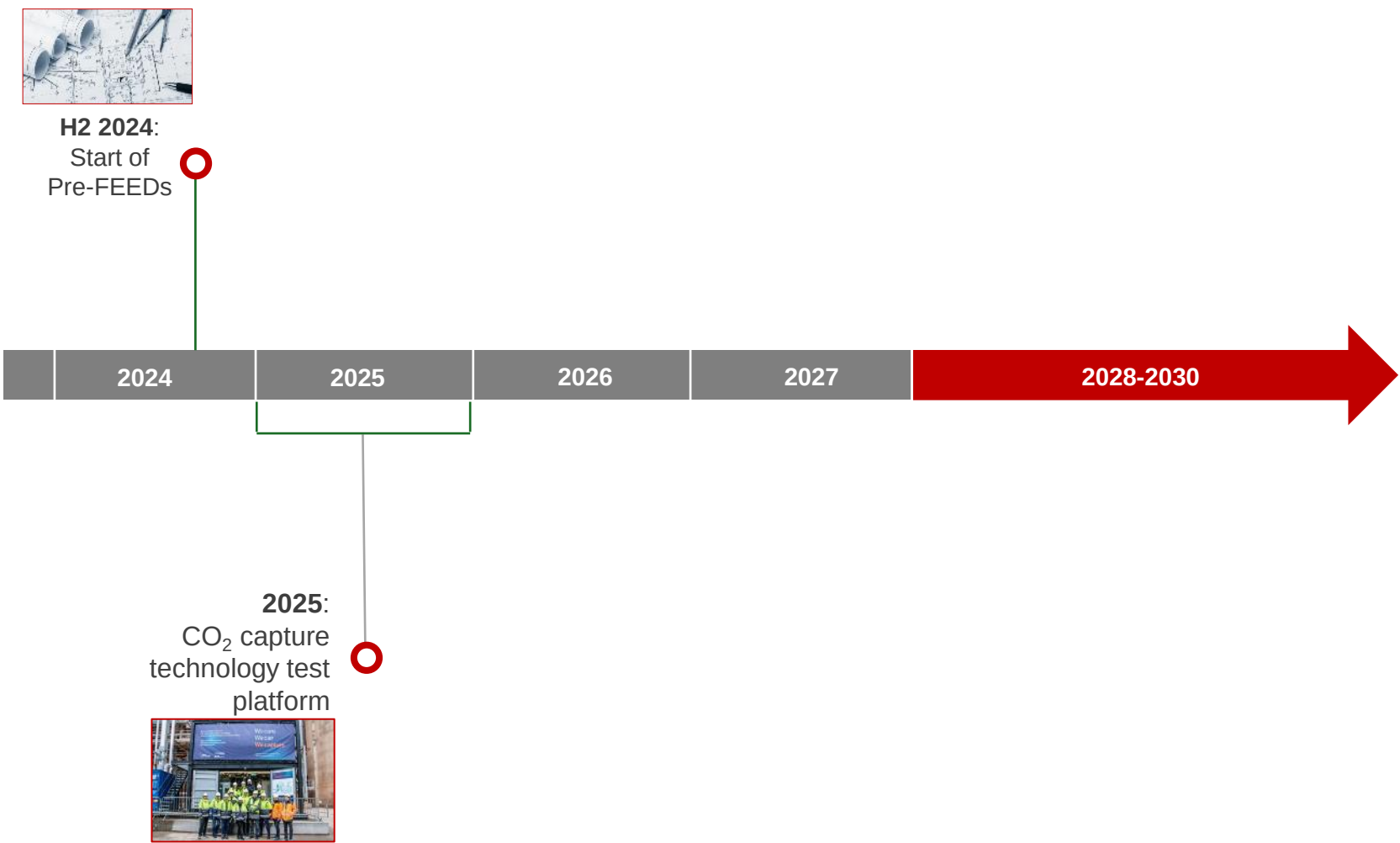


!!!

**From 2040, CO<sub>2</sub> emission allowances will no longer be available => carbon capture or closure of the plant**

# PROJECT TIMELINE

## BROCENI DECARBONIZATION LONG-TERM INDICATIVE TIMELINE



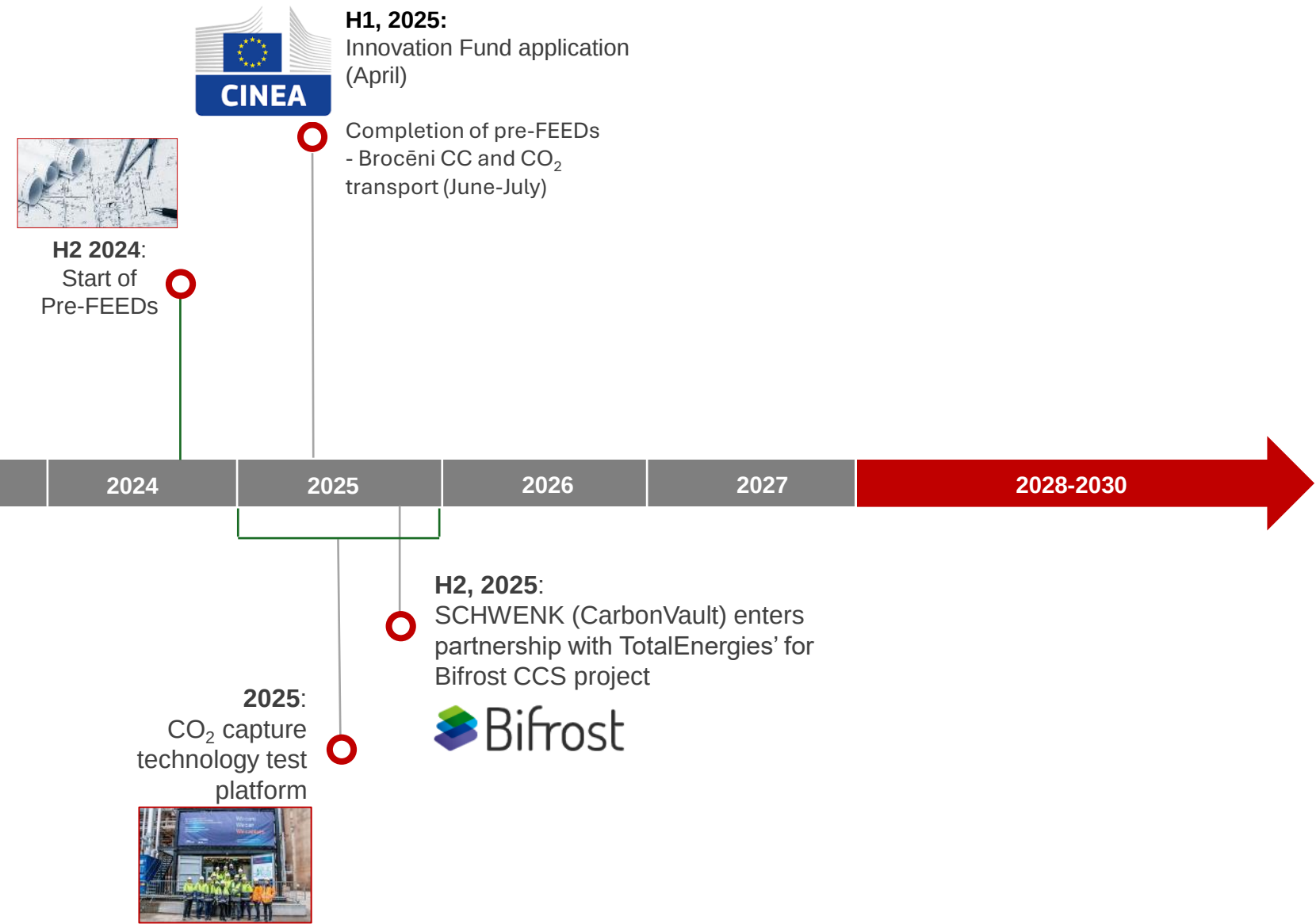


# INAUGURATION OF THE CO<sub>2</sub> CAPTURE TECHNOLOGY TEST BASE



# PROJECT TIMELINE

## BROCENI DECARBONIZATION LONG-TERM INDICATIVE TIMELINE





# PROJECT TIMELINE

## BIFROST CCS PROJECT

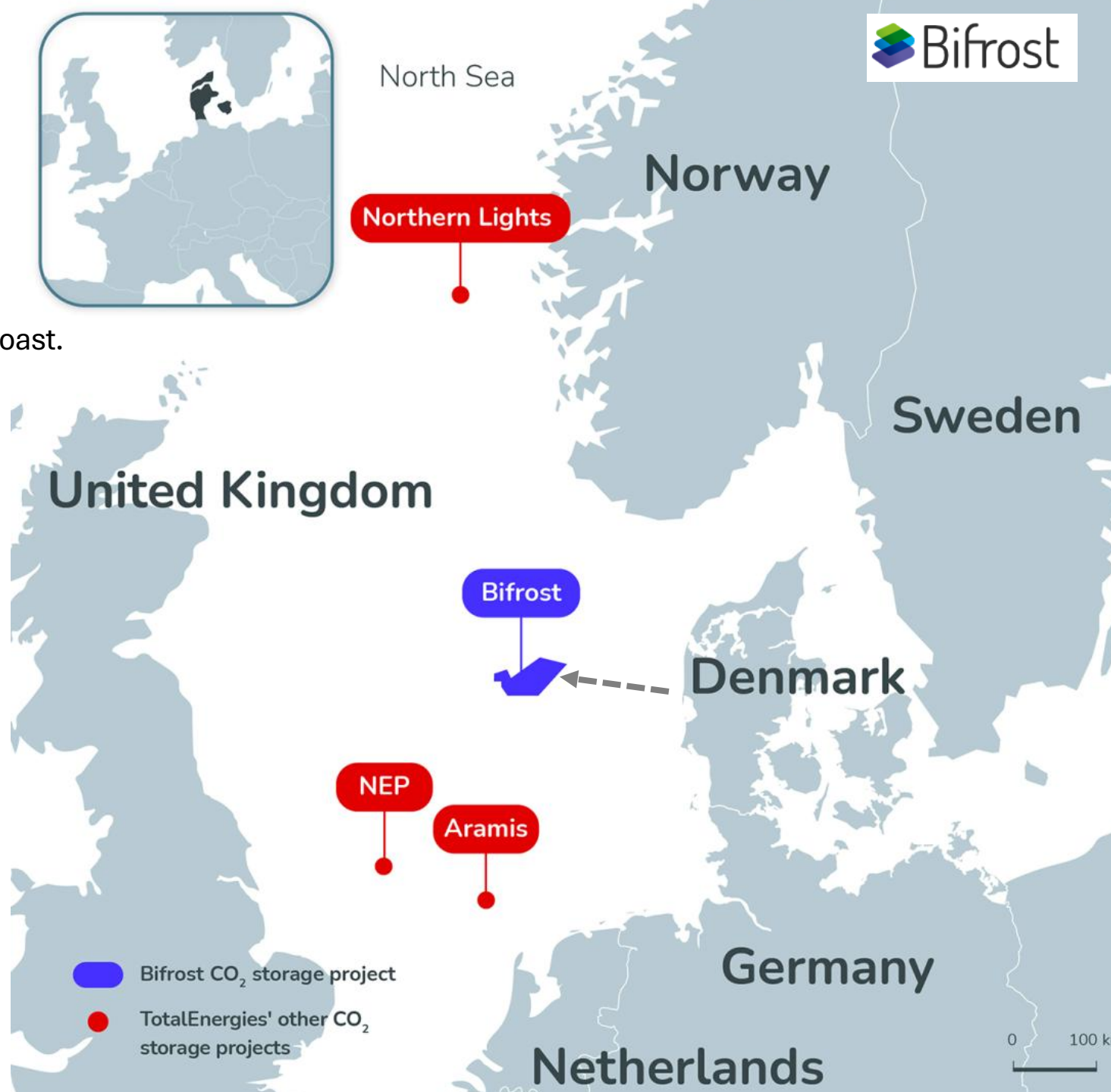
**Location:** Danish North Sea, ~200 km west of Denmark's coast.

**Storage Capacity:** Up to 335 million metric tons

### Key Partners:

- TotalEnergies – Operator (45%)
- SCHWENK Group – Partner (35%)
- Nordsøfonden – Danish state-owned entity(20%)

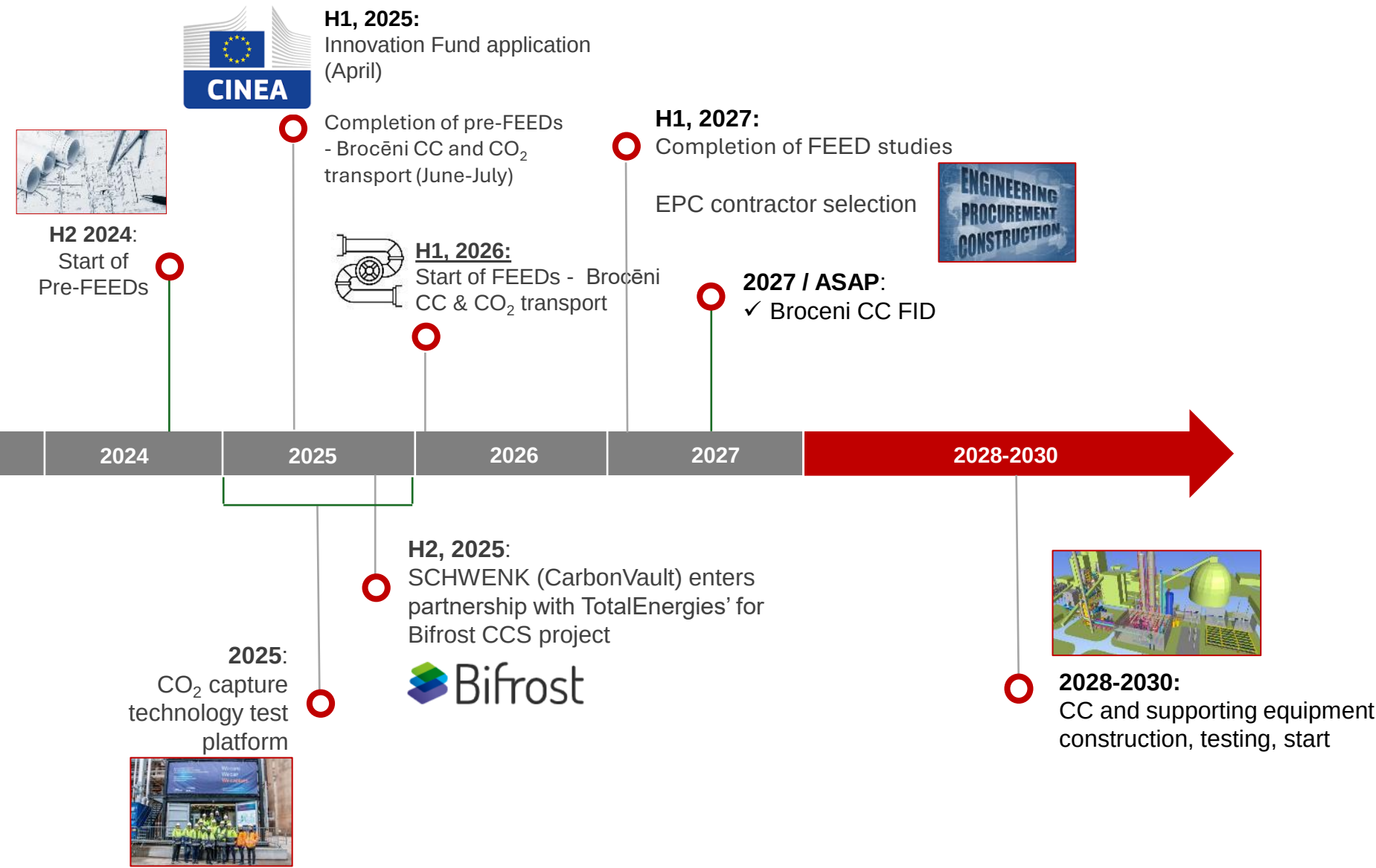
**Start of operation:** Targeted for 2030





# PROJECT TIMELINE

## BROCENI DECARBONIZATION LONG-TERM INDICATIVE TIMELINE



# Thank you!

Krists Mertens

[krists.mertens@schwenk.com](mailto:krists.mertens@schwenk.com)



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**Latvijas  
Betona  
Savienība**

## Tehniskā komiteja 04 – Betona ilgtspēja

Ernests Ozoliņš



# Tehniskā Komiteja - Betona ilgtspēja

- **Izveidota 2024. gada aprīlī**
- **Komisijā pārstāvēti dažādi nozares eksperti:**
  - **No Latvijas lielākajiem betona produktu ražotājiem**
  - **Universitātēm**
  - **Projektētājiem**
- **Tikāties 1 līdz 2 reizes mēnesī kopš komitejas izveidošanas līdz vadlīniju publicēšanai**

# Komitejas mērķi

- **Izstrādāt CO2 gāzu emisiju vidējā līmeņa un samazināšanas līmeņu noteikšanas metodiku Latvijā ražotam betonam**
- **Izstrādāt sistēmu betona, ar samazinātām CO2 emisijām, klasifikācijai Latvijā**

# Kā padarīt betonu zaļāku?

- Aizvietot betonā CEM I tipa cementu ar CEM II tipa cementu

CEM I 52.5 N

## LCA: Results

The LCA results are presented below for the declared unit defined on page 2 of the EPD document.

| Environmental impact                                                                |                                  |                        |          |
|-------------------------------------------------------------------------------------|----------------------------------|------------------------|----------|
|                                                                                     | Indicator                        | Unit                   | A1-A3    |
|    | GWP-total                        | kg CO <sub>2</sub> -eq | 7,05E+02 |
|    | GWP-fossil                       | kg CO <sub>2</sub> -eq | 7,04E+02 |
|    | GWP-biogenic                     | kg CO <sub>2</sub> -eq | 7,33E-01 |
|    | GWP-luluc                        | kg CO <sub>2</sub> -eq | 8,18E-02 |
|    | ODP                              | kg CFC11 -eq           | 1,41E-05 |
|    | AP                               | mol H+ -eq             | 1,90E+00 |
|    | EP-FreshWater                    | kg P -eq               | 4,16E-03 |
|    | EP-Marine                        | kg N -eq               | 7,47E-01 |
|  | EP-Terrestrial                   | mol N -eq              | 8,32E+00 |
|  | POCP                             | kg NMVOC -eq           | 2,01E+00 |
|  | ADP-minerals&metals <sup>1</sup> | kg Sb -eq              | 1,09E-03 |
|  | ADP-fossil <sup>1</sup>          | MJ                     | 1,63E+03 |
|  | WDP <sup>1</sup>                 | m <sup>3</sup>         | 7,18E+04 |

CEM II A-LL 52.5 N

## LCA: Results

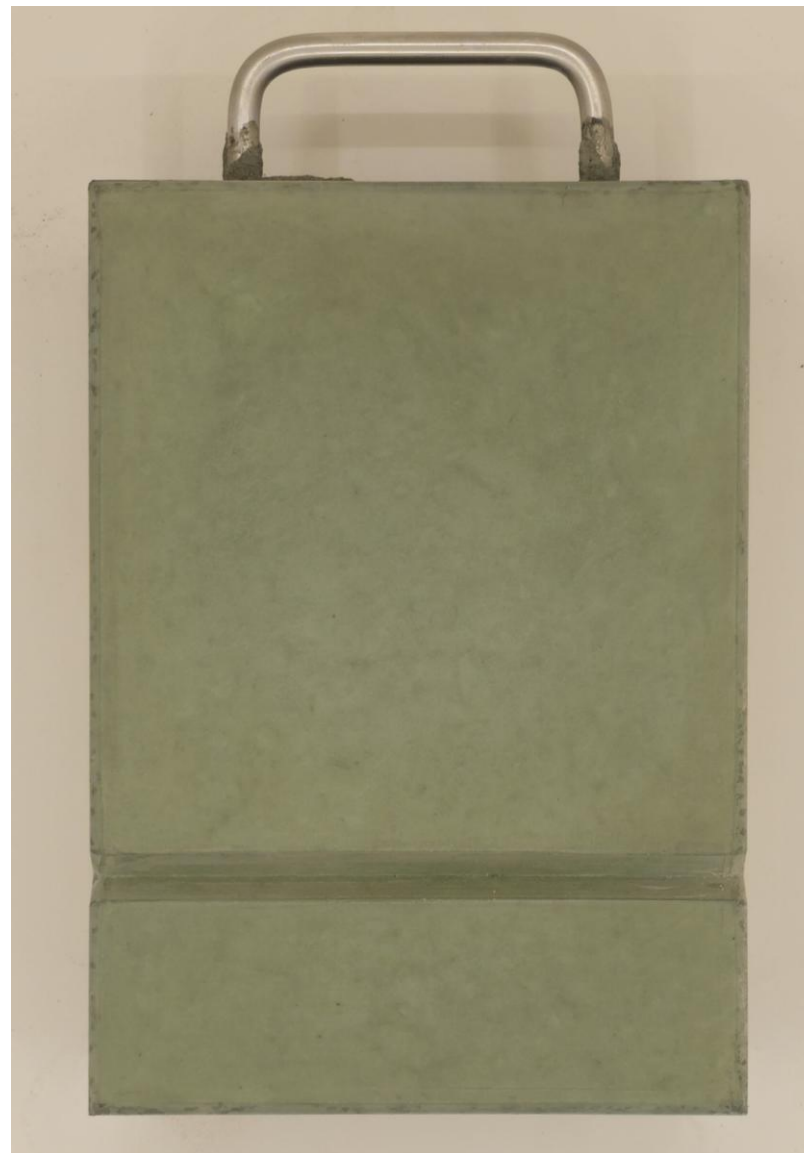
The LCA results are presented below for the declared unit defined on page 2 of the EPD document.

| Environmental impact                                                                  |                                  |                        |          |
|---------------------------------------------------------------------------------------|----------------------------------|------------------------|----------|
|                                                                                       | Indicator                        | Unit                   | A1-A3    |
|    | GWP-total                        | kg CO <sub>2</sub> -eq | 6,33E+02 |
|    | GWP-fossil                       | kg CO <sub>2</sub> -eq | 6,32E+02 |
|    | GWP-biogenic                     | kg CO <sub>2</sub> -eq | 7,04E-01 |
|    | GWP-luluc                        | kg CO <sub>2</sub> -eq | 7,90E-02 |
|    | ODP                              | kg CFC11 -eq           | 1,35E-05 |
|    | AP                               | mol H+ -eq             | 1,72E+00 |
|    | EP-FreshWater                    | kg P -eq               | 3,77E-03 |
|    | EP-Marine                        | kg N -eq               | 6,71E-01 |
|  | EP-Terrestrial                   | mol N -eq              | 7,48E+00 |
|  | POCP                             | kg NMVOC -eq           | 1,80E+00 |
|  | ADP-minerals&metals <sup>1</sup> | kg Sb -eq              | 1,01E-03 |
|  | ADP-fossil <sup>1</sup>          | MJ                     | 1,53E+03 |
|  | WDP <sup>1</sup>                 | m <sup>3</sup>         | 6,96E+04 |



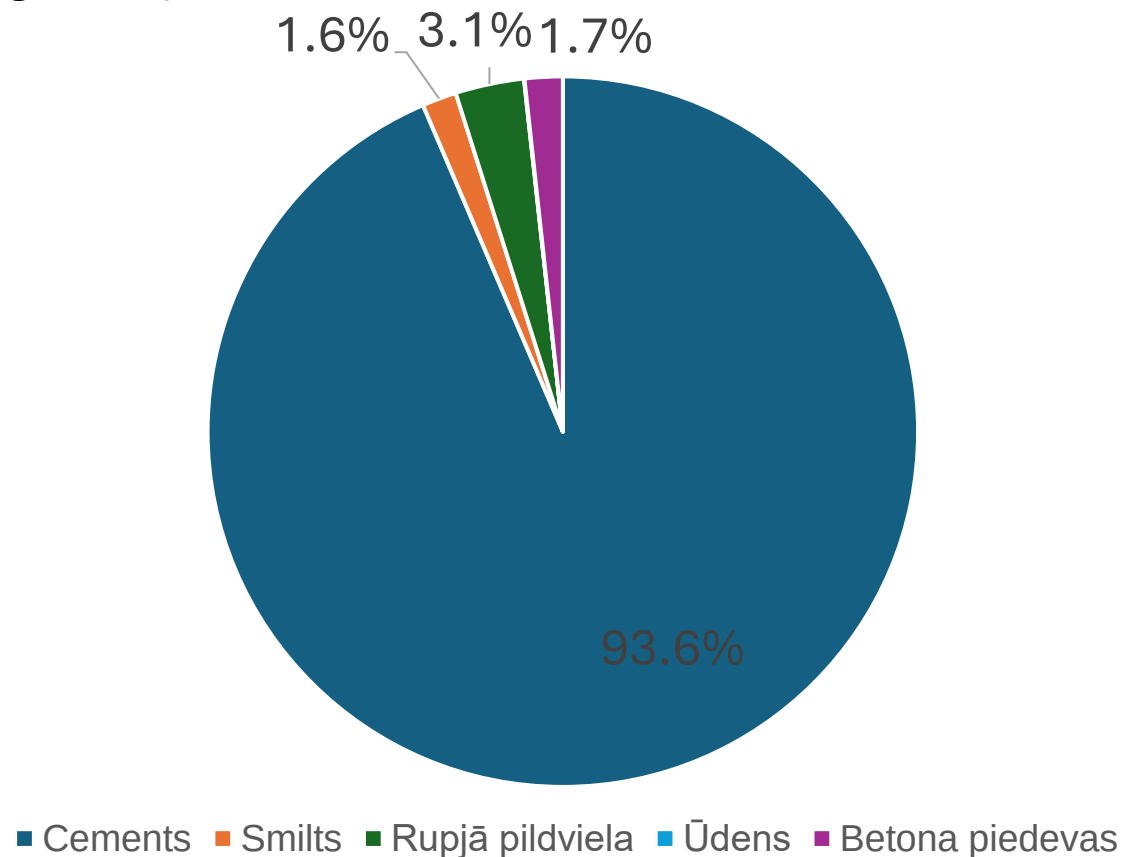
# Kā padarīt betonu zaļāku?

- Aizvietot betonā CEM I tipa cementu ar CEM II tipa cementu
- Pievienot betonam vairāk  $\text{Cr}_2\text{O}_3$  (zaļo pigmentu)



# Kā padarīt betonu zaļāku?

- Aizvietot betonā CEM I tipa cementu ar CEM II tipa cementu
- Pievienot betonam vairāk Cr2O3 (zaļo pigmentu)
- Veikt betona sastāva CO2 aprēķinu



# Kā padarīt betonu zaļāku?

- Aizvietot betonā CEM I tipa cementu ar CEM II tipa cementu
- Pievienot betonam vairāk Cr2O3 (zaļo pigmentu)
- Veikt betona sastāva CO2 aprēķinu
- Samazināt specificēto betona stiprības klasi

| Izmaiņa                 | Specifiska izmaiņa                                                                        | Ietekme uz emisijām                        | Komentāri                                                                                       |
|-------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------|
| Ilgmūžība               | Kalpošanas laika palielināšana līdz 100 gadiem                                            | +10–15 kg CO <sub>2</sub> e/m <sup>3</sup> | Ilgāks kalpošanas laiks samazina pilna dzīves cikla emisijas                                    |
| Pildvielas              | Maksimālā pildvielas izmēra samazināšana līdz 8 mm                                        | +10–15 kg CO <sub>2</sub> e/m <sup>3</sup> |                                                                                                 |
|                         | Maksimālā pildvielas izmēra palielināšana līdz 32 mm                                      | -10–15 kg CO <sub>2</sub> e/m <sup>3</sup> |                                                                                                 |
| Konsistence             | Konsistences klases maiņa uz S3                                                           | -5–10 kg CO <sub>2</sub> e/m <sup>3</sup>  |                                                                                                 |
|                         | Konsistences klases maiņa uz S5                                                           | +5–10 kg CO <sub>2</sub> e/m <sup>3</sup>  |                                                                                                 |
| Specifikācijas prasības | Palielināt specifikācijā norādīto stiprības sasniegšanas vecumu no 28 dienām uz 90 dienām | -15–30 kg CO <sub>2</sub> e/m <sup>3</sup> | Izmantojot 90 dienas, tiek dota iespēja palielināt aizstājējmateriālu proporciju betona sastāvā |
|                         | Samazināt specifikācijā norādīto stiprības sasniegšanas vecumu no 28 dienām uz 7 dienām   | +20–40 kg CO <sub>2</sub> e/m <sup>3</sup> | Izmantojot 7 dienas, tiek samazinātas iespējas izmantot cementa aizstājējmateriālus             |

Tabula 8.  
CO<sub>2</sub>e emisijas betona sastāviem un emisiju samazinājuma līmeņiem.

| Betona grupa     | Betona stiprības klase | References betona emisijas A1–A3, kg CO <sub>2</sub> e / m <sup>3</sup> | LR B+90% | LR B+80% | LR B+70% |
|------------------|------------------------|-------------------------------------------------------------------------|----------|----------|----------|
| Parastais betons | C8/10                  | 200                                                                     | 180      | 160      | 140      |
|                  | C12/15                 | 210                                                                     | 190      | 170      | 145      |
|                  | C16/20                 | 225                                                                     | 205      | 180      | 160      |
|                  | C20/25                 | 240                                                                     | 215      | 190      | 170      |
|                  | C25/30                 | 255                                                                     | 230      | 205      | 180      |
|                  | C30/37                 | 275                                                                     | 250      | 220      | 195      |
|                  | C35/45                 | 300                                                                     | 270      | 240      | 210      |
|                  | C40/50                 | 325                                                                     | 295      | 260      | 230      |
|                  | C45/55                 | 350                                                                     | 315      | 280      | 245      |
|                  | C50/60                 | 370                                                                     | 335      | 295      | 260      |





# Kā padarīt betonu zaļāku?

- Aizvietot betonā CEM I tipa cementu ar CEM II tipa cementu
- Pievienot betonam vairāk  $\text{Cr}_2\text{O}_3$  (zaļo pigmentu)
- Veikt betona sastāva  $\text{CO}_2$  aprēķinu
- Samazināt specificēto betona stiprības klasi
- Palielināt betona cenu

# Kā padarīt betonu zaļāku?

- Aizvietot betonā CEM I tipa cementu ar CEM II tipa cementu
- Pievienot betonam vairāk Cr2O3 (zaļo pigmentu)
- Veikt betona sastāva CO2 aprēķinu
- Samazināt specificēto betona stiprības klasi
- Palielināt betona cenu
- Specificēt zema CO2 betonu agrā stadijā vispirms jautājot betona ražotājam par iespējām lietot projektā zaļāku betonu

| Strength class <sub>1</sub> and low carbon class                                                               | B20 <sub>3</sub> | B25 <sub>3</sub> | B30 | B35 | B45 | B55 | B65 |
|----------------------------------------------------------------------------------------------------------------|------------------|------------------|-----|-----|-----|-----|-----|
| Maximum permitted greenhouse gas emissions, GWP total [kg CO <sub>2</sub> -eq. per m <sup>3</sup> of concrete] |                  |                  |     |     |     |     |     |
| Industry Reference <sub>4</sub>                                                                                | 200              | 210              | 245 | 270 | 300 | 310 | 330 |
| Low Carbon B                                                                                                   | 180              | 190              | 225 | 240 | 270 | 280 | 300 |
| Low Carbon A                                                                                                   | 160              | 170              | 200 | 210 | 220 | 230 | 240 |
| Low Carbon Plus <sub>2</sub>                                                                                   | 135              | 140              | 150 | 160 | 170 | 180 | 190 |
| Low Carbon Extreme <sub>2</sub>                                                                                | 100              | 105              | 110 | 120 | 130 | 140 | 150 |

# Betona CO2 nospieduma klasifikācija

- Pirmais šāda tipa dokuments Baltijā
- Noteiktas references betona CO2e emisijas un izmešu samazināšanas līmeņi
- Rīks pasūtītājam, lai noteiktu vēlamo emisiju līmeni un varētu viegli salīdzināt dažādu ražotāju piedāvājumu
- Demokratizēti CO2e aprēķini
  - Rīks betona ražotājam, lai saprastu savu CO2e emisiju līmeni



## TRUK4 BETONA ILGTSPĒJA

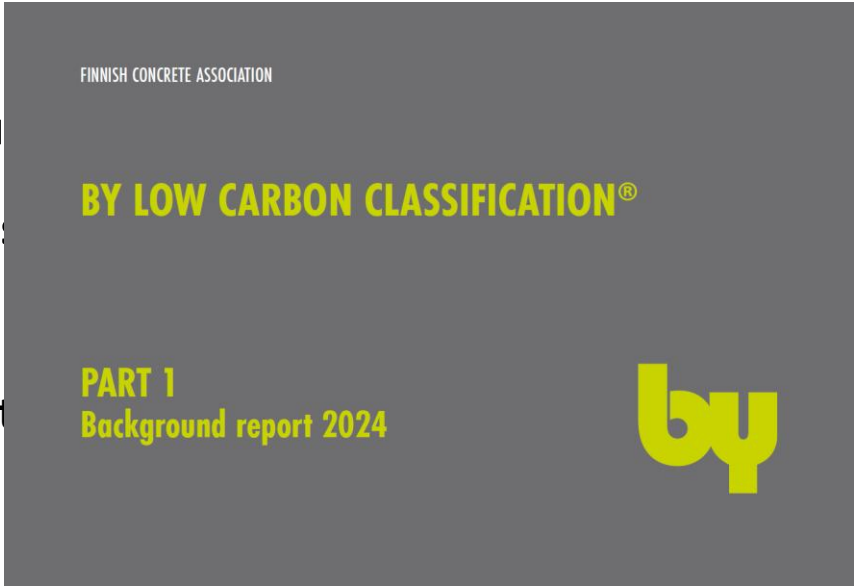
Latvijas Betona savienības  
tehniskās vadlīnijas Nr. 1  
Betona CO<sub>2</sub> nospieduma  
klasifikācija



Latvijas  
Betona  
Savienība



# Metodoloģija - Darbība



Publikasjon nr. 37

Lavkarbonbetong

stu

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Schwenk CEM I

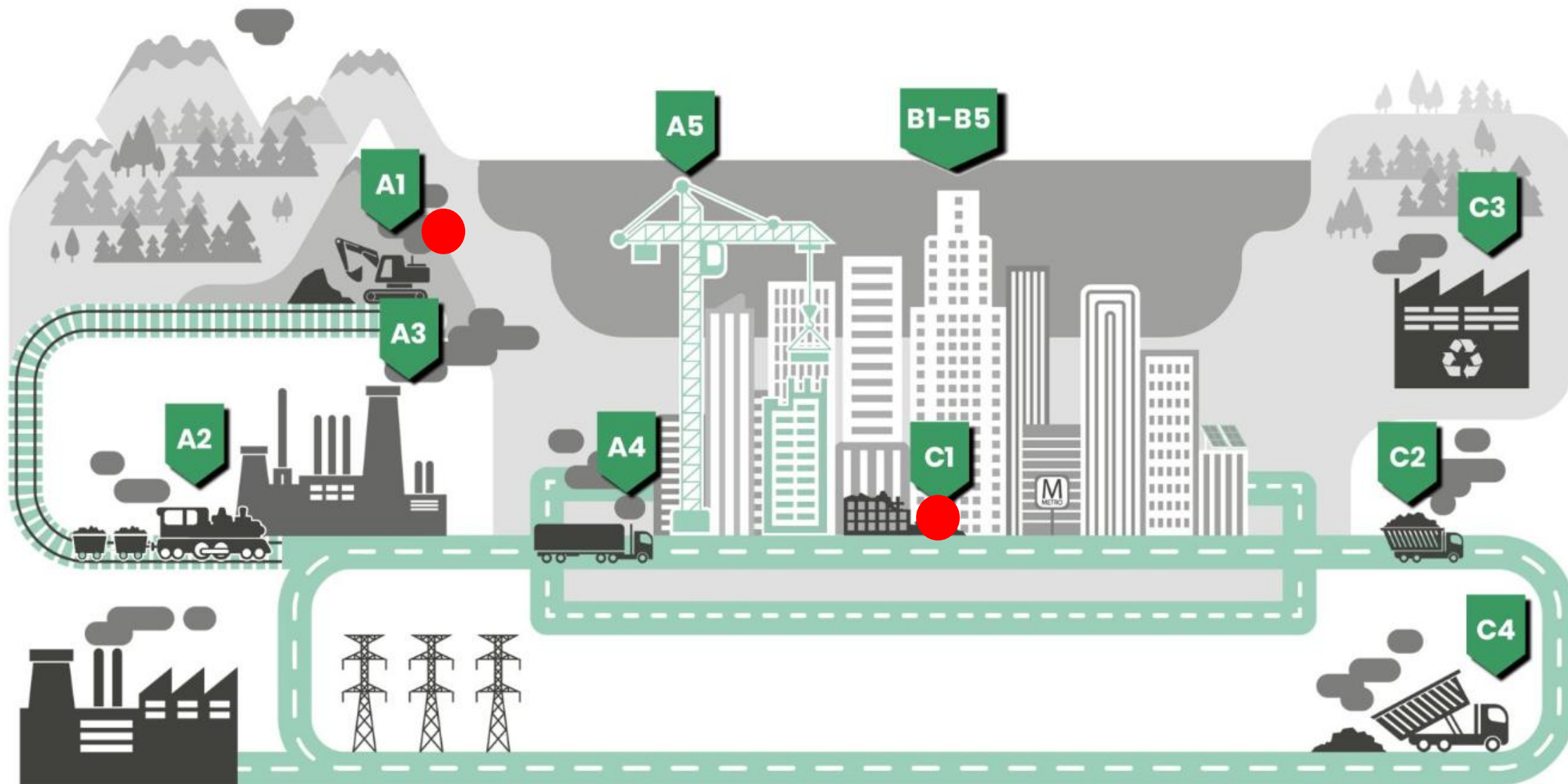
eni

s klase

|        |                        |
|--------|------------------------|
| C16/20 | X0                     |
| C20/25 | XC2                    |
| C25/30 | XC2; XF1               |
| C30/37 | XC4; XD2; XF1          |
| C35/45 | XC4; XS1; XD2; XF1; XA |
| C40/50 | XC4; XS3; XD3; XF1; XA |
| C45/55 | XC4; XS3; XD3; XF1; XA |
| C50/60 | XC4; XS3; XD3; XF1; XA |

Mai 2020

# Dzīves cikla stadijas



# Metodoloģija - CO2 emisiju aprēķini

- Emisiju aprēķini veikti pēc vienota standarta EN 15804+A2:2019 principiem
  - Aprēķinos iekļautas dzīvescikla stadijas:
    - A1 – Emisijas no izejmateriāliem
    - A2 – Emisijas no izejmateriālu transporta līdz ražotnei
    - A3 – Emisijas no ražošanas procesa
  - Aprēķinos nav iekļauta dzīves cikla sadaļa A gatavā produkta transports līdz klientam
- Lai veiktu aprēķinus definējām:
  - Izejmateriālus un to emisiju faktorus
  - Transporta veidus un to emisiju faktorus
    - Izejmateriālu transporta vidējos attālumus
  - Citus emisiju ietekmējošus faktorus

## IZEJMATERIĀLU TRANSPORTS

Tabula 5.  
Izejvielu transportēšanas attālumi, kas izmantoti ziņojumā.

| Izejmateriālu grupa | Materiāls                     | km ar smago mašīnu | km ar kuģi | km ar vilcienu  |
|---------------------|-------------------------------|--------------------|------------|-----------------|
| Cements             | CEM I 52,5 N                  | 106 <sup>a</sup>   | -          | 42 <sup>a</sup> |
|                     | CEM I 42,5 N-SR 3 MH/LA       | 106 <sup>a</sup>   | -          | 42 <sup>a</sup> |
| Pildvielas          | Smilts                        | 120                | -          | -               |
|                     | Dabīgā un drupinātā pildviela | 120                | -          | -               |
|                     | Drupināts granīts             | 70                 | 1500       | -               |
| Ūdens               | Ūdens                         | -                  | -          | -               |

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Tabula 6.  
Specifiskās emisijas izejmateriālu transporta veidiem.

| Transporta veids                             | Specifiskās emisijas kg CO <sub>2</sub> e/tkm | Avots/komentārs                                                                |
|----------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------|
| Smagā automašīna; Izmēra klase >32 t; EURO 5 | 0,0908 <sup>2</sup>                           | Ecoinvent 3.8: transport, load factor 50%, road operation, round trip included |
| Kuģis                                        | 0,0065 <sup>2</sup>                           | Ecoinvent 3.8: transport, bulk carrier, ship                                   |
| Vilciens                                     | 0,0567 <sup>2</sup>                           | Ecoinvent 3.8: Transport, freight train, diesel                                |



# Kā CO2 emisijas tiek aprēķinātas?

- Parastais C30/37 betons
  - Cements 330 kg/m<sup>3</sup>
  - Ūdens 182 kg/m<sup>3</sup>
  - Smalkā pildviela 926 kg/m<sup>3</sup>
  - Rupjā pildviela 926 kg/m<sup>3</sup>

**Tabula 1.**  
Parastā betona sastāvi.

| Betona stiprības klase | Vides iedarbības klase/-s | ū/c attiecība | Cements, kg/m <sup>3</sup> |
|------------------------|---------------------------|---------------|----------------------------|
| C8/10                  | X0                        | 0.80          | 220                        |
| C12/15                 | X0                        | 0.75          | 240                        |
| C16/20                 | X0                        | 0.70          | 260                        |
| C20/25                 | XC2                       | 0.65          | 280                        |
| C25/30                 | XC2; XF1                  | 0.60          | 300                        |
| C30/37                 | XC4; XD2; XF1             | 0.55          | 330                        |
| C35/45                 | XC4; XS1; XD2; XF1; XA1   | 0.50          | 360                        |
| C40/50                 | XC4; XS3; XD3; XF1; XA1   | 0.45          | 400                        |
| C45/55                 | XC4; XS3; XD3; XF1; XA1   | 0.40          | 430                        |
| C50/60                 | XC4; XS3; XD3; XF1; XA1   | 0.38          | 460                        |

# A1 stadijas emisijas

- Cements 330 kg/m<sup>3</sup>
- Cementa specifiskās emisijas – 705 kg CO<sub>2</sub>e/t
- Betona sastāvā: 330 \* 1.02 \*

## LCA: Results

The LCA results are presented below for the declared unit defined on page 2 of the EPD document.

| Environmental impact                                                                |                                  |                        |          |          |
|-------------------------------------------------------------------------------------|----------------------------------|------------------------|----------|----------|
|                                                                                     | Indicator                        | Unit                   | A1-A3    | A4       |
|    | GWP-total                        | kg CO <sub>2</sub> -eq | 7,05E+02 | 1,93E+01 |
|    | GWP-fossil                       | kg CO <sub>2</sub> -eq | 7,04E+02 | 1,93E+01 |
|    | GWP-biogenic                     | kg CO <sub>2</sub> -eq | 7,33E-01 | 6,09E-03 |
|    | GWP-luluc                        | kg CO <sub>2</sub> -eq | 8,18E-02 | 6,67E-03 |
|    | ODP                              | kg CFC11-eq            | 1,41E-05 | 4,20E-06 |
|    | AP                               | mol H+ -eq             | 1,90E+00 | 3,24E-01 |
|  | EP-FreshWater                    | kg P -eq               | 4,16E-03 | 1,03E-04 |
|  | EP-Marine                        | kg N -eq               | 7,47E-01 | 7,24E-02 |
|  | EP-Terrestrial                   | mol N -eq              | 8,32E+00 | 8,14E-01 |
|  | POCP                             | kg NMVOC -eq           | 2,01E+00 | 2,21E-01 |
|  | ADP-minerals&metals <sup>1</sup> | kg Sb -eq              | 1,09E-03 | 2,12E-04 |
|  | ADP-fossil <sup>1</sup>          | MJ                     | 1,63E+03 | 2,81E+02 |
|  | WDP <sup>1</sup>                 | m <sup>3</sup>         | 7,18E+04 | 1,47E+02 |

## IZEJVIELU EMISIJAS

Tabula 4.

Izejvielu specifiskās emisijas.

| Izejmateriālu grupa | Materiāls                     | Datu avots                 | EN15804 tips | Specifiskās emisijas kg CO <sub>2</sub> e/t |
|---------------------|-------------------------------|----------------------------|--------------|---------------------------------------------|
| Cements             | CEM I 52,5 N                  | EPD <sup>5</sup>           | +A2:2019     | 705,0                                       |
|                     | CEM I 42,5 N-SR 3 MH/LA       | EPD <sup>6</sup>           | +A2:2019     | 715,0                                       |
| Pildvielas          | Smilts                        | Ecoinvent 3.8 <sup>2</sup> | +A2:2019     | 4,2                                         |
|                     | Dabīgā un drupinātā pildviela | Ecoinvent 3.8 <sup>2</sup> | +A2:2019     | 8,4                                         |
|                     | Drupināts granīts             | EPD <sup>7</sup>           | +A2:2019     | 8,4                                         |
| Ūdens               | Ūdens                         | Ecoinvent 3.8 <sup>2</sup> | +A2:2019     | 0,3                                         |

# A2 stadijas emisijas

- Smalkā pildviela 926 kg/m<sup>3</sup>
- Vidēji tiek transportēts 120 km ar smago automašīnu
- Smagās automašīnas specifiskās emisijas – 0.0908 kg CO<sub>2</sub>e/tkm
- Smilts transportam:  $926 * 120 * \frac{0.0908}{1000} * 1.02 = 10.29 \text{ kg CO}_2\text{e}$

## IZEJMATERIĀLU TRANSPORTS

Tabula 5.

Izejvielu transportēšanas attālumi, kas izmantoti ziņojumā.

| Izejmateriālu grupa | Materiāls                     | km ar smago mašīnu | km ar kuģi | km ar vilcienu  |
|---------------------|-------------------------------|--------------------|------------|-----------------|
| Cements             | CEM I 52,5 N                  | 106 <sup>a</sup>   | -          | 42 <sup>a</sup> |
|                     | CEM I 42,5 N-SR 3 MH/LA       | 106 <sup>a</sup>   | -          | 42 <sup>a</sup> |
| Pildvielas          | Smilts                        | 120                | -          | -               |
|                     | Dabīgā un drupinātā pildviela | 120                | -          | -               |
|                     | Drupināts granīts             | 70                 | 1500       | -               |
| Ūdens               | Ūdens                         | -                  | -          | -               |

Tabula 6.

Specifiskās emisijas izejmateriālu transporta veidiem.

| Transporta veids                             | Specifiskās emisijas kg CO <sub>2</sub> e/tkm | Avots/komentārs                                                                |
|----------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------|
| Smagā automašīna; Izmēra klase >32 t; EURO 5 | 0,0908 <sup>2</sup>                           | Ecoinvent 3.8: transport, load factor 50%, road operation, round trip included |
| Kuģis                                        | 0,0065 <sup>2</sup>                           | Ecoinvent 3.8: transport, bulk carrier, ship                                   |
| Vilciens                                     | 0,0567 <sup>2</sup>                           | Ecoinvent 3.8: Transport, freight train, diesel                                |



# A3 stadijas emisijas

## EMISIJU DATU IZVĒLES METODOLOĢIJA

Izejvielu emisijas, kuras aprēķiniem apstiprinājusi tehniskā komiteja "TK04 Betona ilgtspēja", apkopotas tabulā 4., apstiprinātie transportlīdzekļi, transportlīdzekļu emisijas un attālumi katram no izejmateriāliem apkopoti tabulā 5. un tabulā 6., bet apstiprinātās enerģijas avotu emisijas transportbetona ražošanai apkopotas tabulā 7. Izvēloties emisiju vērtības izejvielām, komiteja izvēlējās konkrētu materiālu vides produktu deklarāciju (EPD), ja tāda aprēķinu veikšanas brīdī bija pieejama, pretējā gadījumā tika izmantoti vispārīgi, industrijas vidējie izejvielu dati no Ecoinvent 3.8 datubāzes<sup>2</sup>.

Tā kā cementu Latvijā iespējams piegādāt ar diviem transporta veidiem – kravas automašīnu vai vilcienu, – aprēķinos izmantoti vidējie transporta attālumi katram no transporta veidiem, kuri pēc tam tiek proporcionāli sadalīti, balstoties uz būvmateriālu ražotāja "Schwenk Latvija" cementa pārvadājumu apjomu katram transporta veidam 2023. gadā.

Vidējās vērtības, kas iegūtas no lielākajiem transportbetona ražotājiem, tiek izmantotas, lai novērtētu enerģijas patērinu un ražotņu patērēto siltumenerģiju visa gada laikā. **2,6 kg CO<sub>2</sub>e/m<sup>3</sup>** ir komitejas noteiktā vērtība, kas sastāv no emisijām, ko rada 7,6 kWh / m<sup>3</sup> elektroenerģijas un 6,9 kWh / m<sup>3</sup> dabasgāzes apkurei, kas tiek patērētas viena kubikmetra betona saražošanai.



# Kopējās emisijas A1-A3 stadijām C30/37 parastais betons

- **Cements**

- A1 – 237.3 kg CO<sub>2</sub>e
- A2 – 4.04 kg CO<sub>2</sub>e

- **Smalkā pildviela**

- A1 – 3.97 kg CO<sub>2</sub>e
- A2 – 10.29 kg CO<sub>2</sub>e

- **Rupjā pildviela**

- A1 – 7.94 kg CO<sub>2</sub>e
- A2 – 10.29 kg CO<sub>2</sub>e

- **A3 sadaļa**

- 2.6 kg CO<sub>2</sub>e /m<sup>3</sup>

- **Kopā 276.43 kg CO<sub>2</sub>e/m<sup>3</sup>**

**Tabula 8.**

CO<sub>2</sub>e emisijas betona sastāviem un emisiju samazinājuma līmeņiem.

| Betona grupa                                      | Betona stiprības klase | References betona emisijas A1-A3, kg CO <sub>2</sub> e / m <sup>3</sup> | LR B*90% | LR B*80% | LR B*70% | LR B*60% | LR B*50% | LR B*40% |
|---------------------------------------------------|------------------------|-------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|
| Parastais betons                                  | C8/10                  | 200                                                                     | 180      | 160      | 140      | 120      | 100      | 80       |
|                                                   | C12/15                 | 210                                                                     | 190      | 170      | 145      | 125      | 105      | 85       |
|                                                   | C16/20                 | 225                                                                     | 205      | 180      | 160      | 135      | 115      | 90       |
|                                                   | C20/25                 | 240                                                                     | 215      | 190      | 170      | 145      | 120      | 95       |
|                                                   | C25/30                 | 255                                                                     | 230      | 205      | 180      | 155      | 130      | 100      |
|                                                   | C30/37                 | 275                                                                     | 250      | 220      | 195      | 165      | 140      | 110      |
|                                                   | C35/45                 | 300                                                                     | 270      | 240      | 210      | 180      | 150      | 120      |
|                                                   | C40/50                 | 325                                                                     | 295      | 260      | 230      | 195      | 165      | 130      |
|                                                   | C45/55                 | 350                                                                     | 315      | 280      | 245      | 210      | 175      | 140      |
| Sala izturīgs betons                              | C50/60                 | 370                                                                     | 335      | 295      | 260      | 220      | 185      | 150      |
|                                                   | C30/37                 | 300                                                                     | 270      | 240      | 210      | 180      | 150      | 120      |
|                                                   | C35/45                 | 320                                                                     | 290      | 255      | 225      | 190      | 160      | 130      |
|                                                   | C40/50                 | 350                                                                     | 315      | 280      | 245      | 210      | 175      | 140      |
|                                                   | C45/55                 | 370                                                                     | 335      | 295      | 260      | 220      | 185      | 150      |
| Sala izturīgs betons ar sala izturīgām pildvielām | C50/60                 | 390                                                                     | 350      | 310      | 275      | 235      | 195      | 155      |
|                                                   | C30/37                 | 315                                                                     | 285      | 250      | 220      | 190      | 160      | 125      |
|                                                   | C35/45                 | 340                                                                     | 305      | 270      | 240      | 205      | 170      | 135      |
|                                                   | C40/50                 | 365                                                                     | 330      | 290      | 255      | 220      | 185      | 145      |
|                                                   | C45/55                 | 390                                                                     | 350      | 310      | 275      | 235      | 195      | 155      |
|                                                   | C50/60                 | 405                                                                     | 365      | 325      | 285      | 245      | 205      | 160      |

# Nepatīk rēķināt?

- <https://betonaco2kalkulators.lv/>

## BETONA CO<sub>2</sub> KALKULĀTORS BŪS PĒC

**85**

Dienas

**17**

Stundas

**13**

Minūtes

**07**

Sekundes



# Neto un Bruto cementa emisijas

$$\text{Neto CO}_2\text{e emisijas} = \text{Bruto CO}_2\text{e emisijas} - \text{Alternatīvā kurināmā radītās CO}_2\text{e emisijas}$$

- Bruto emisijas – visas CO<sub>2</sub> emisijas, kas rodas ražošanas procesā
- **Princips – piesārņotājs maksā**
- Būtiska ietekme uz cementa un betona CO<sub>2</sub> emisijām
- **CEM I cementam no 705 kg CO<sub>2</sub>e/t samazinājums uz 571 kg CO<sub>2</sub>e/t (Par 19 %)**

## LCA: Results

The LCA results are presented below for the declared unit defined on page 2 of the EPD document.

| Environmental impact                                                                |              |                        |          |          |
|-------------------------------------------------------------------------------------|--------------|------------------------|----------|----------|
|                                                                                     | Indicator    | Unit                   | A1-A3    | A4       |
|  | GWP-total    | kg CO <sub>2</sub> -eq | 7,05E+02 | 1,93E+01 |
|  | GWP-fossil   | kg CO <sub>2</sub> -eq | 7,04E+02 | 1,93E+01 |
|  | GWP-biogenic | kg CO <sub>2</sub> -eq | 7,33E-01 | 6,09E-03 |
|  | GWP-luluc    | kg CO <sub>2</sub> -eq | 8,18E-02 | 6,67E-03 |

## LCA, Results

The LCA results are presented below for the declared unit defined on page 2 of the EPD document.

| Environmental impact                                                                  |              |                        |          |          |
|---------------------------------------------------------------------------------------|--------------|------------------------|----------|----------|
|                                                                                       | Indicator    | Unit                   | A1-A3    | A4       |
|   | GWP-total    | kg CO <sub>2</sub> -eq | 5.71E+02 | 2.54E+01 |
|  | GWP-fossil   | kg CO <sub>2</sub> -eq | 5.70E+02 | 2.54E+01 |
|  | GWP-biogenic | kg CO <sub>2</sub> -eq | 6.72E-01 | 7.34E-03 |
|  | GWP-luluc    | kg CO <sub>2</sub> -eq | 7.89E-02 | 9.04E-03 |

# CO2 emisiju līmeņi

| Betona grupa                                      | Betona stiprības klase | References betona emisijas A1-A3, kg CO <sub>2</sub> e / m <sup>3</sup> | Neto (Bruto) vērtības |           |           |           |           |           |
|---------------------------------------------------|------------------------|-------------------------------------------------------------------------|-----------------------|-----------|-----------|-----------|-----------|-----------|
|                                                   |                        |                                                                         | LRB*90%               | LRB*80%   | LRB*70%   | LRB*60%   | LRB*50%   | LRB*40%   |
| Parastais betons                                  | C8/10                  | 170 (200)                                                               | 155 (180)             | 135 (160) | 120 (140) | 100 (120) | 85 (100)  | 70 (80)   |
|                                                   | C12/15                 | 180 (210)                                                               | 160 (190)             | 145 (170) | 125 (145) | 110 (125) | 90 (105)  | 70 (85)   |
|                                                   | C16/20                 | 190 (225)                                                               | 170 (205)             | 150 (180) | 135 (160) | 115 (135) | 95 (115)  | 75 (90)   |
|                                                   | C20/25                 | 200 (240)                                                               | 180 (215)             | 160 (190) | 140 (170) | 120 (145) | 100 (120) | 80 (95)   |
|                                                   | C25/30                 | 215 (255)                                                               | 195 (230)             | 170 (205) | 150 (180) | 130 (155) | 110 (130) | 85 (100)  |
|                                                   | C30/37                 | 230 (275)                                                               | 205 (250)             | 185 (220) | 160 (195) | 140 (165) | 115 (140) | 90 (110)  |
|                                                   | C35/45                 | 250 (300)                                                               | 225 (270)             | 200 (240) | 175 (210) | 150 (180) | 125 (150) | 100 (120) |
|                                                   | C40/50                 | 270 (325)                                                               | 245 (295)             | 215 (260) | 190 (230) | 160 (195) | 135 (165) | 110 (130) |
|                                                   | C45/55                 | 290 (350)                                                               | 260 (315)             | 230 (280) | 205 (245) | 175 (210) | 145 (175) | 115 (140) |
|                                                   | C50/60                 | 305 (370)                                                               | 275 (335)             | 245 (295) | 215 (260) | 185 (220) | 155 (185) | 120 (150) |
| Sala izturīgs betons                              | C30/37                 | 250 (300)                                                               | 225 (270)             | 200 (240) | 175 (210) | 150 (180) | 125 (150) | 100 (120) |
|                                                   | C35/45                 | 265 (320)                                                               | 240 (290)             | 210 (255) | 185 (225) | 160 (190) | 135 (160) | 105 (130) |
|                                                   | C40/50                 | 290 (350)                                                               | 260 (315)             | 230 (280) | 205 (245) | 175 (210) | 145 (175) | 115 (140) |
|                                                   | C45/55                 | 305 (370)                                                               | 275 (335)             | 245 (295) | 215 (260) | 185 (220) | 155 (185) | 120 (150) |
|                                                   | C50/60                 | 325 (390)                                                               | 295 (350)             | 260 (310) | 230 (275) | 195 (235) | 165 (195) | 130 (155) |
| Sala izturīgs betons ar sala izturīgām pildvielām | C30/37                 | 265 (315)                                                               | 240 (285)             | 210 (250) | 185 (220) | 160 (190) | 135 (160) | 105 (125) |
|                                                   | C35/45                 | 280 (340)                                                               | 250 (305)             | 225 (270) | 195 (240) | 170 (205) | 140 (170) | 110 (135) |
|                                                   | C40/50                 | 305 (365)                                                               | 275 (330)             | 245 (290) | 215 (255) | 185 (220) | 155 (185) | 120 (145) |
|                                                   | C45/55                 | 325 (390)                                                               | 295 (350)             | 260 (310) | 230 (275) | 195 (235) | 165 (195) | 130 (155) |
|                                                   | C50/60                 | 335 (405)                                                               | 300 (365)             | 270 (325) | 235 (285) | 200 (245) | 170 (205) | 135 (160) |



**Latvijas  
Betona  
Savienība**

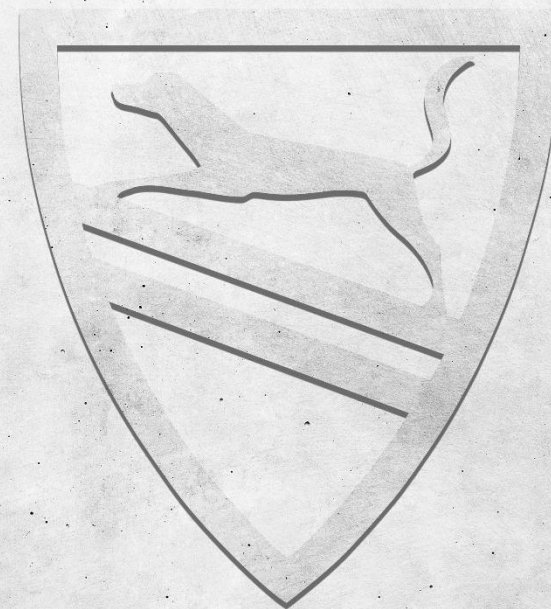
**Paldies par uzmanību!**



# ZEMĀKAS OGLEKĻA PĒDAS CEMENTU LIETOŠANAS IESPĒJAS INFRASTRUKTŪRAS BETONĀ LATVIJĀ

Rīga, 27.11.2025

J.Zāle



**SCHWENK**

## TĒMAS AKTUALITĀTE

- Latvijas Valsts Ceļu noteiktajās Tiltu specifikācijās ir atļauts lietot tikai CEM I tipa portlandcementu ar C3A saturu  $<3\%$ , un praktiski arī sārmu saturu  $<0,6\%$ .
- Eiropas zaļā kursa ietvaros un visas cementa industrijas dekarbonizācijas kontekstā, jau šobrīd tirgū tiek piedāvāti un betonā izmantoti kompozītcementi ar aizvien pieaugošu piedevu daudzumu un no CEM I cementa paredzēts atteikties jau tuvākajos gados.
- Betona ilgmūžība izmantojot dažādus kompozītcementus Latvijā nav pētīta, nepieciešama arī testēšanas programma, pēc kuras var novērtēt un salīdzināt dažādu cementu veikspēju.



# MĒRĶIS UN UZDEVUMI

- Veikt betona ilgmūžības īpašību salīdzināšanu «tiltu» betoniem ar divām dažādām Ū/C attiecībām un Latvijā pieejamajiem kompozītcementiem;
- Izstrādāt testēšanas programmu potenciālai cementa atbilstības izvērtēšanai priekš tiltu konstrukcijām;
- Izvērtēt iegūtos rezultātus un sniegt tālākās rekomendācijas.





# PĒTĪJUMA PROGRAMMA

Pieci dažādi Latvijas tirgū pieejami cementa veidi:

- **CEM I 42,5 N SR3 (references)** – «tīrs» portlandcements
- **CEM II/A-LL 52,5 N** – kaļķakmens kompozītcements
- **CEM II/B-M (S-LL) 52,5 N** – šlagas un kaļķakmens kompozītcements
- **CEM II/B-M (P-LL) 52,5 N** – opokas un kaļķakmens kompozītcements
- **CEM II/A-V 52,5 N** – smalko disperso pelnu kompozītcements

- betona maisījumi un paraugu izgatavošana ar 2 definētām tiltu konstrukcijām raksturīgajām ūdens/cementa attiecībām ar katru cementa veidu;

# PĒTĪJUMA PROGRAMMA

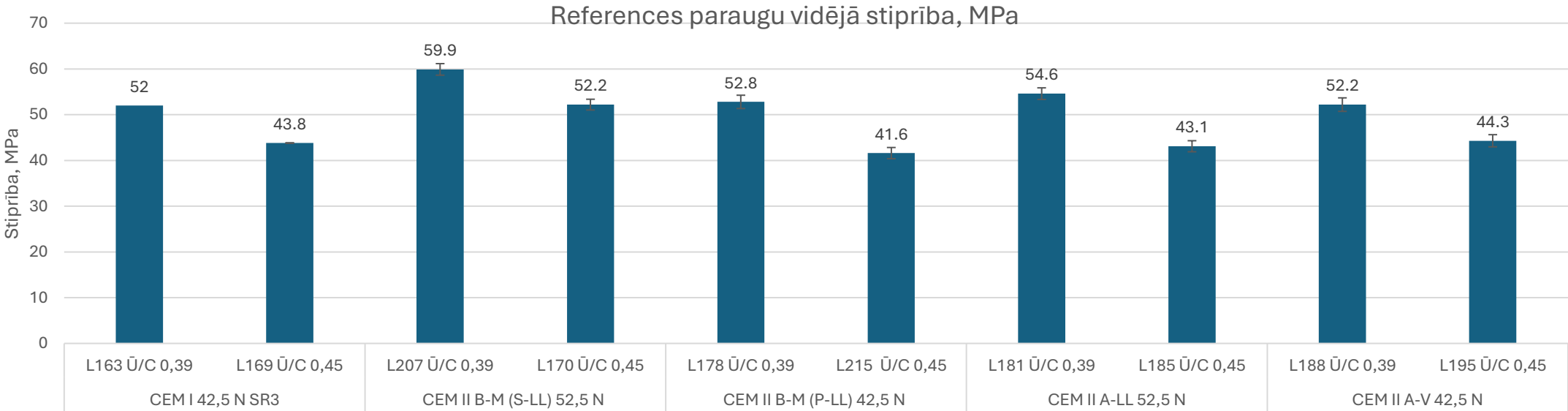
## Testēšanas metodes:

- Betona salizturība:
    - CEN/TS 12390-9
    - LVS 156-1 testēšanas metodes (F300);
    - gaisa poru analīze sacietējušā betonā
  - Karbonizācijas ātrums:
    - Standarta metode EN 12390-10
    - Paātrinātā metode EN 12390-12
  - Hlorīdu iespiešanās dziļums NT Build 492
    - Tests 70 dienu vecumā
    - Tests 180 dienu vecumā
- Papildus ilgmūžības aspektu izpēte:
- Betona sulfātizturība atbilstoši Šveices standartam SIA 262/1:2019 – izplešanās mērījumi;
  - Sārnu-silīcija dioksīda reakcijas izraisītie bojājumi – ASTM C1260 28 dienu tests uz izplešanos.



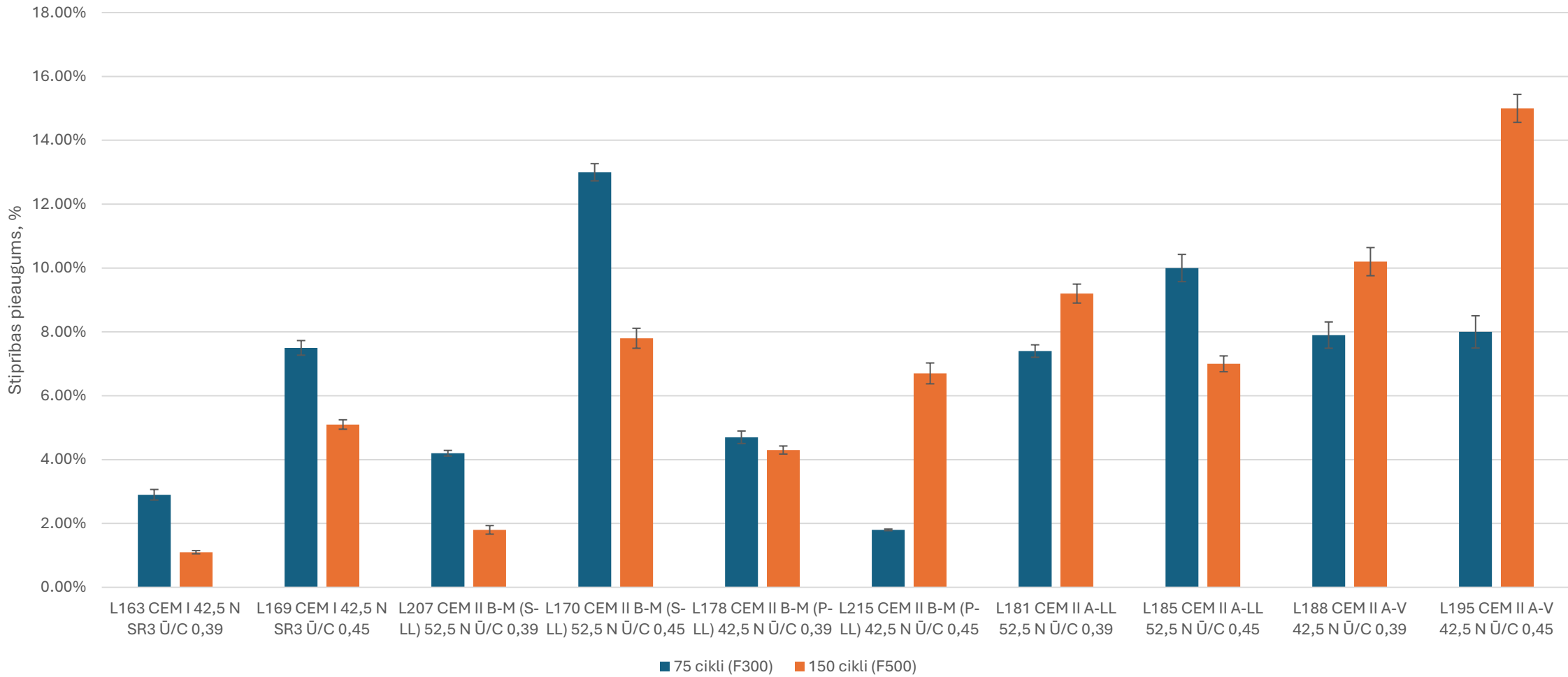
SVAIGA BETONA TESTU REZULTĀTI

| Paraugu identifikācija | L163                | L169 | L207                     | L170 | L178                     | L215 | L181               | L185 | L188              | L195 |
|------------------------|---------------------|------|--------------------------|------|--------------------------|------|--------------------|------|-------------------|------|
|                        | CEM I 42,5 N<br>SR3 |      | CEM II/B-M (S-LL) 52,5 N |      | CEM II/B-M (P-LL) 52,5 N |      | CEM II/A-LL 52,5 N |      | CEM II/A-V 42,5 N |      |
| Ū/C attiecība          | 0,39                | 0,45 | 0,39                     | 0,45 | 0,39                     | 0,45 | 0,39               | 0,45 | 0,39              | 0,45 |
| Gaisa saturs, %        | 6,1%                | 5,8% | 6,2%                     | 5,5% | 4,6%                     | 6,0% | 4,8%               | 5,3% | 5,3%              | 5,0% |
| Blīvums, kg/m³         | 2305                | 2276 | 2319                     | 2276 | 2320                     | 2292 | 2304               | 2319 | 2322              | 2339 |
| Konusa nosēdums, cm    | 17,5                | 18,5 | 22,0                     | 22,0 | 8,5                      | 20,0 | 18,0               | 20,0 | 25,5              | 25,0 |



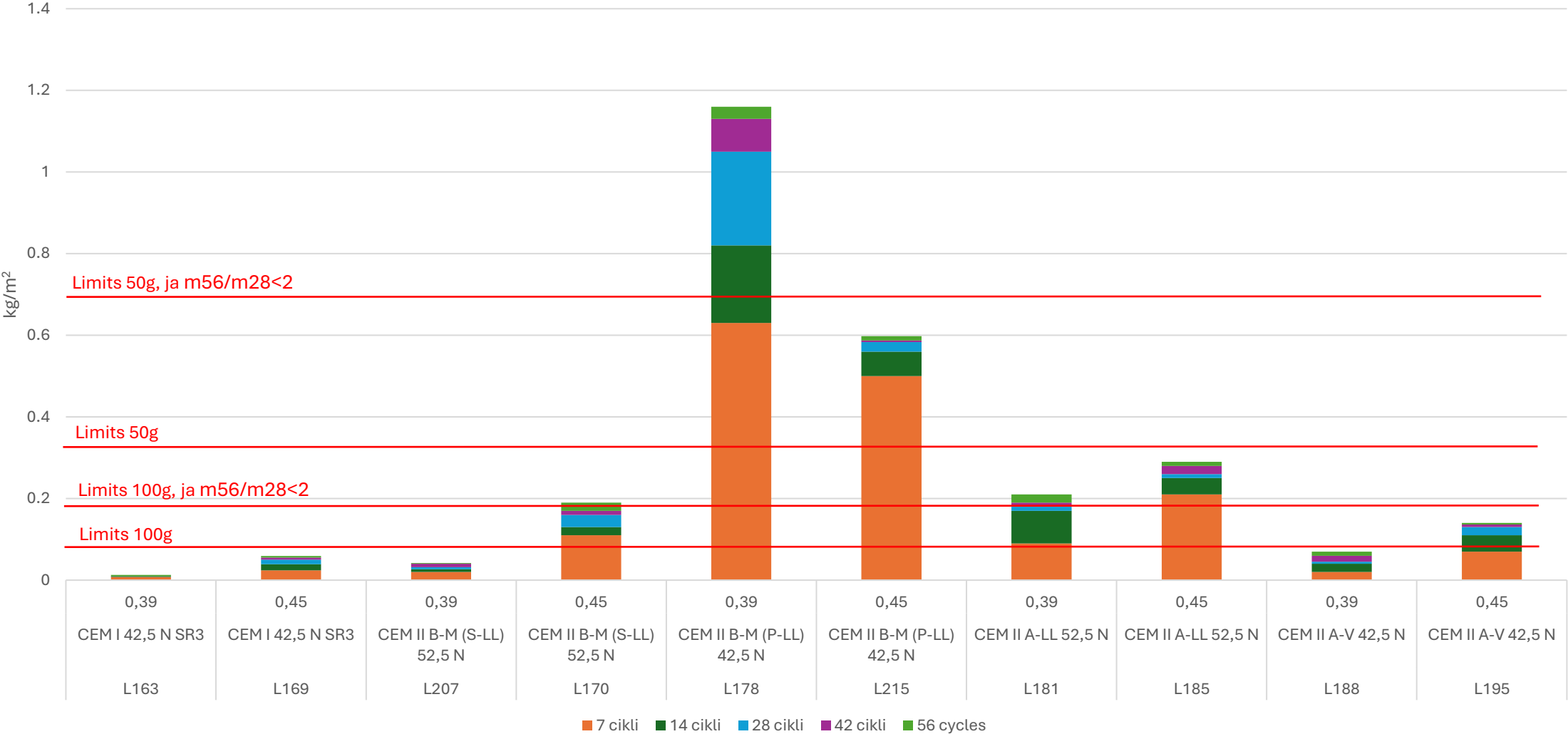


Betona salizturība – stiprības zudumu metode LVS 156-1 (A pielikums)



# SALIZTURĪBA

Salizturība - virsmas masas zudumu testa metode



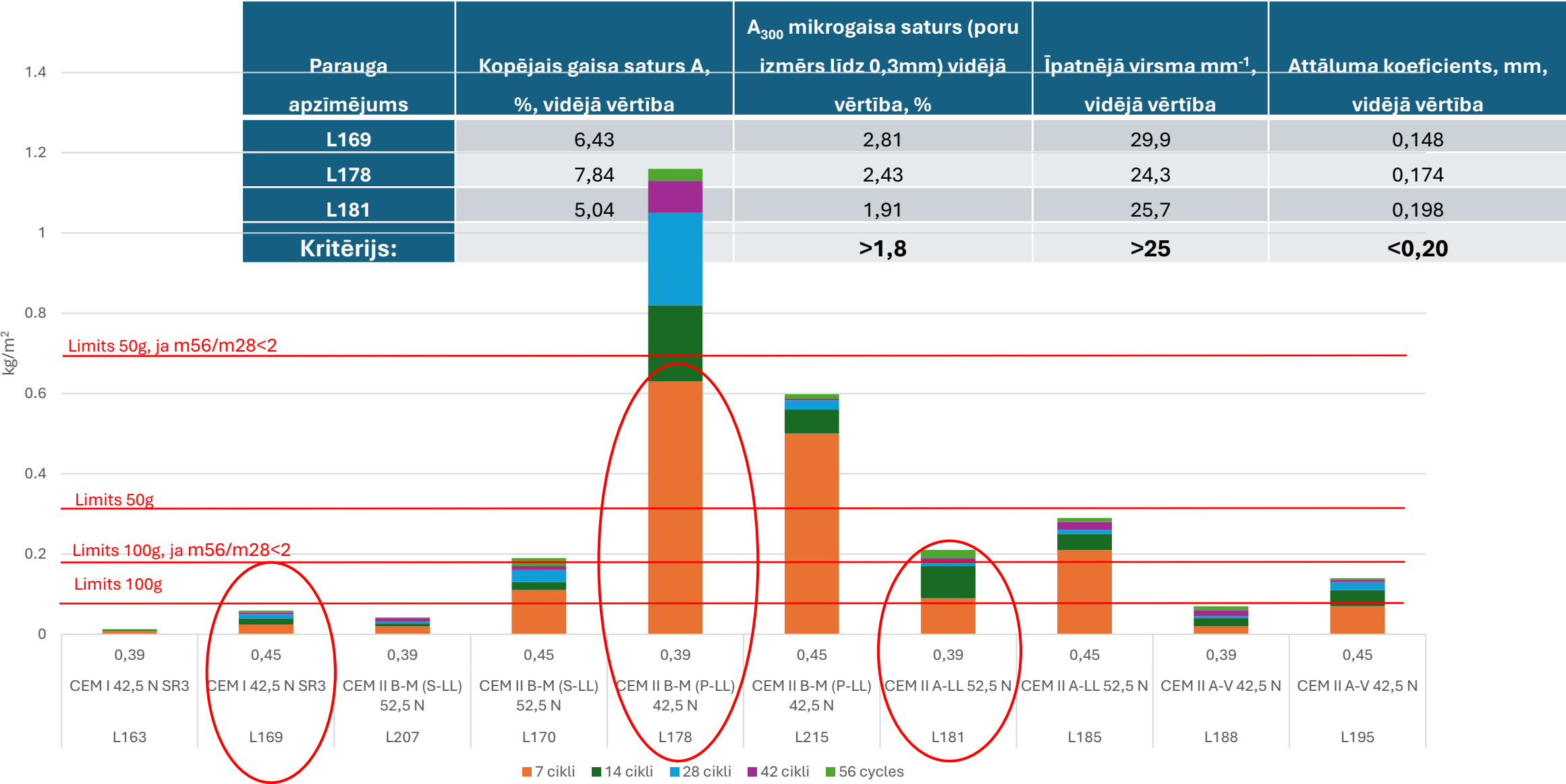
SALIZTURĪBA

Gaisa poru analīze sacietējušā betonā

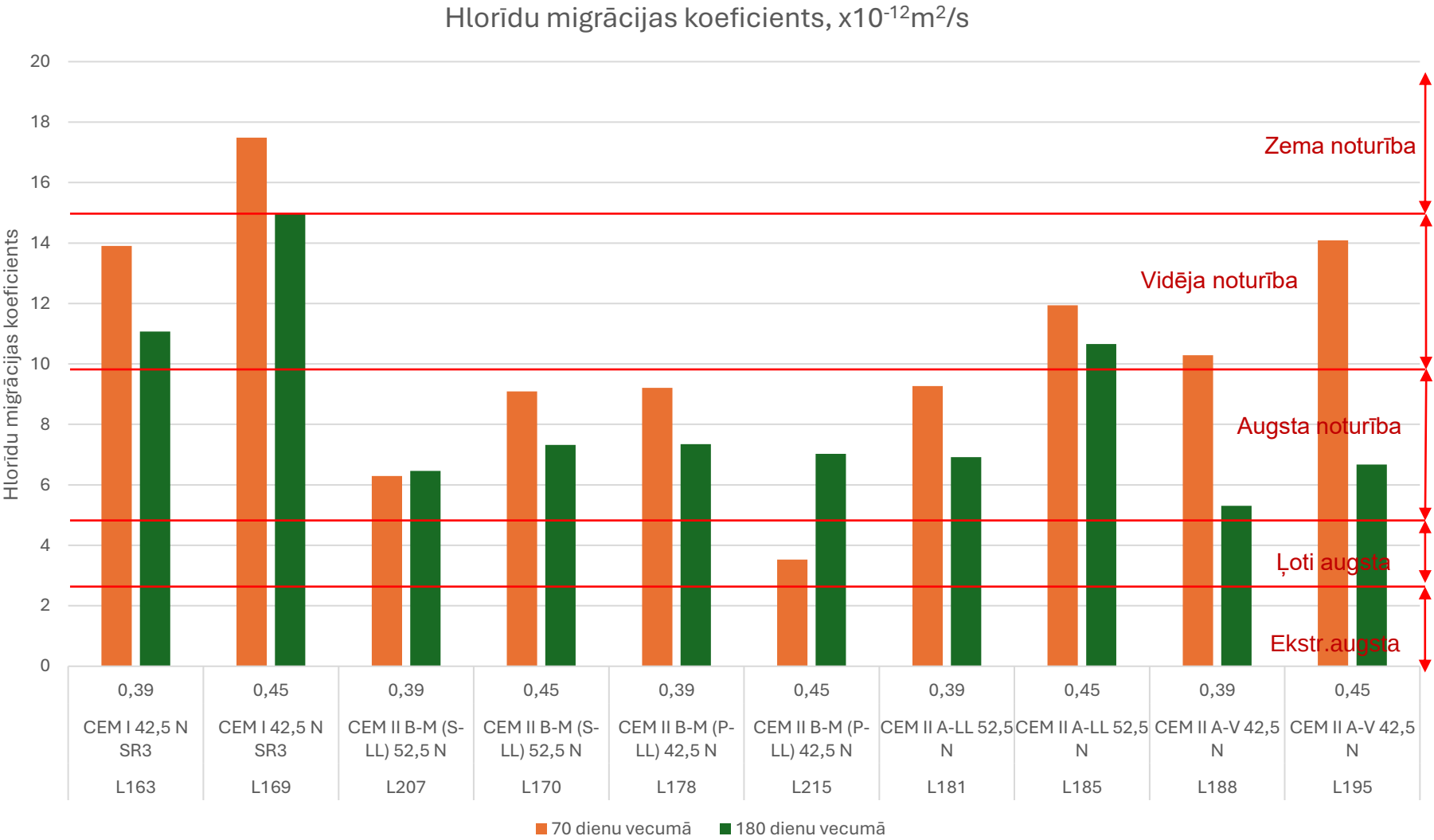
| Parauga<br>apzīmējums | Kopējais gaisa<br>saturš A, %, vidējā<br>vērtība | A <sub>300</sub> mikrogaisa<br>saturš (poru izmērs<br>līdz 0,3mm) vidējā<br>vērtība, % | Īpatnējā virsma<br>mm <sup>-1</sup> , vidējā<br>vērtība | Attāluma<br>koeficients, mm,<br>vidējā vērtība |
|-----------------------|--------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------|
| L169                  | 6,43                                             | 2,81                                                                                   | 29,9                                                    | 0,148                                          |
| L178                  | 7,84                                             | 2,43                                                                                   | 24,3                                                    | 0,174                                          |
| L181                  | 5,04                                             | 1,91                                                                                   | 25,7                                                    | 0,198                                          |
| Kritērijs:            |                                                  | >1,8                                                                                   | >25                                                     | <0,20                                          |



SALIZTURĪBA

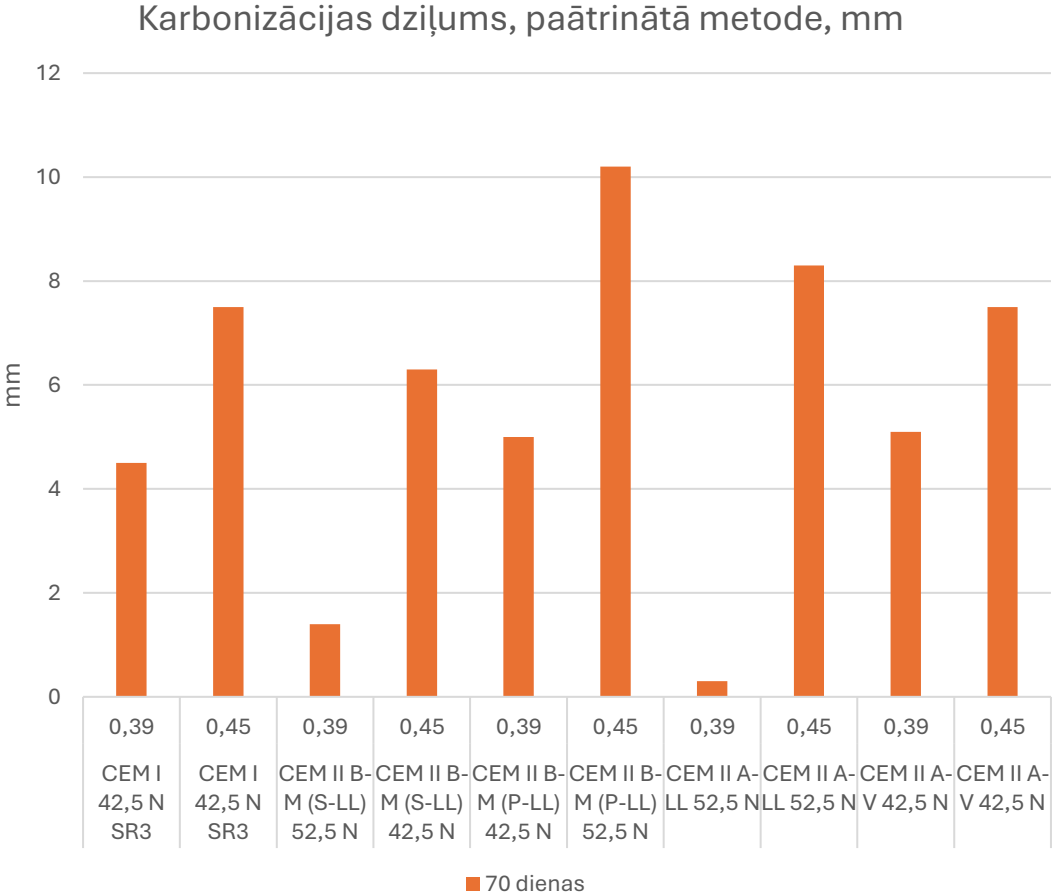
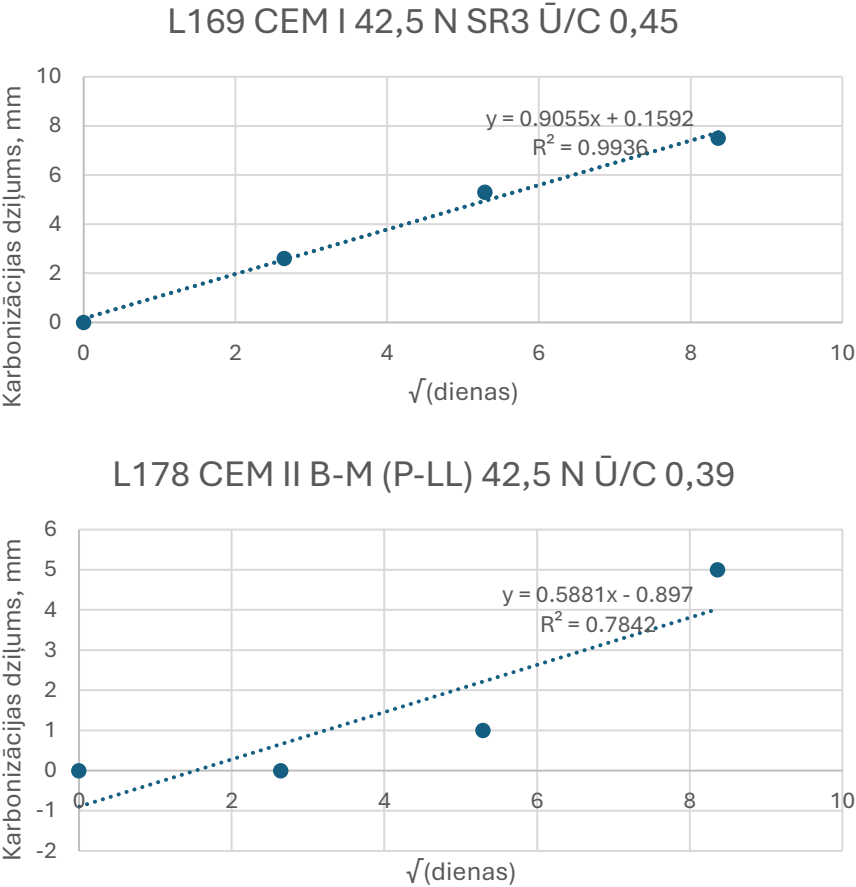


# HĻORĪDU IZTURĪBA



| Resistance to chloride migration |                |
|----------------------------------|----------------|
| Dnssm                            | 28 days test   |
| >15                              | Low            |
| 10-15                            | Moderate       |
| 5-10                             | High           |
| 2,5-5                            | Very high      |
| <2,5                             | Extremely high |

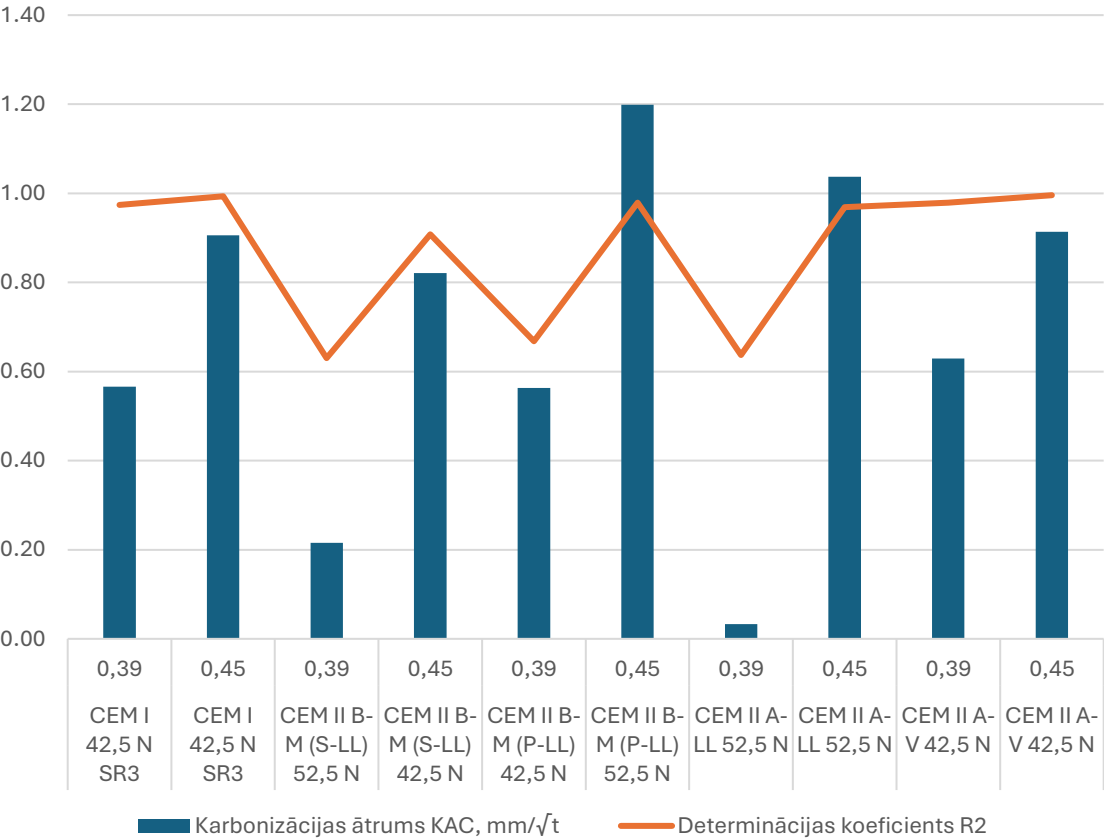
# BETONA KARBONIZĀCIJA



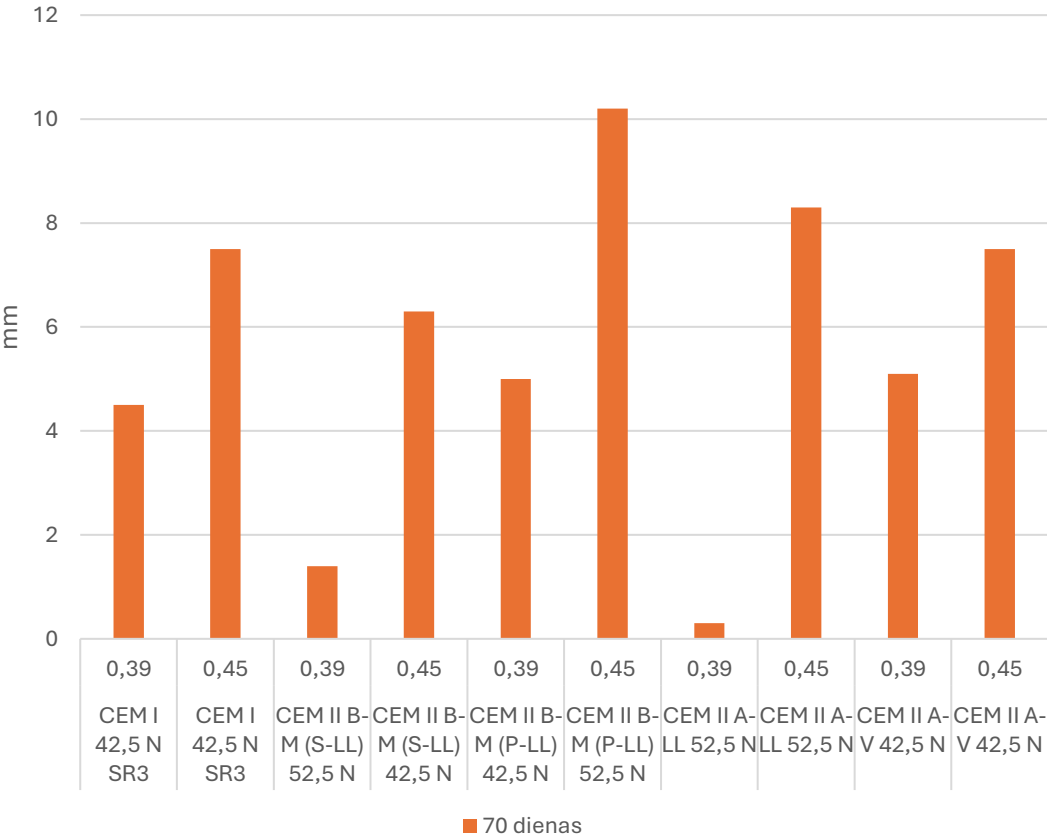
NOTE 1 With normal concrete compositions, the carbonation depth at 70 days is expected to be  $\geq 4$  mm. A value lower than this indicates a concrete with high carbonation resistance, but the precision estimates given in Clause 10 are not applicable to carbonation rates based on very low carbonation depths.

# BETONA KARBONIZĀCIJA

Karbonizācijas ātrums - paātrinātā metode



Karbonizācijas dziļums, paātrinātā metode, mm

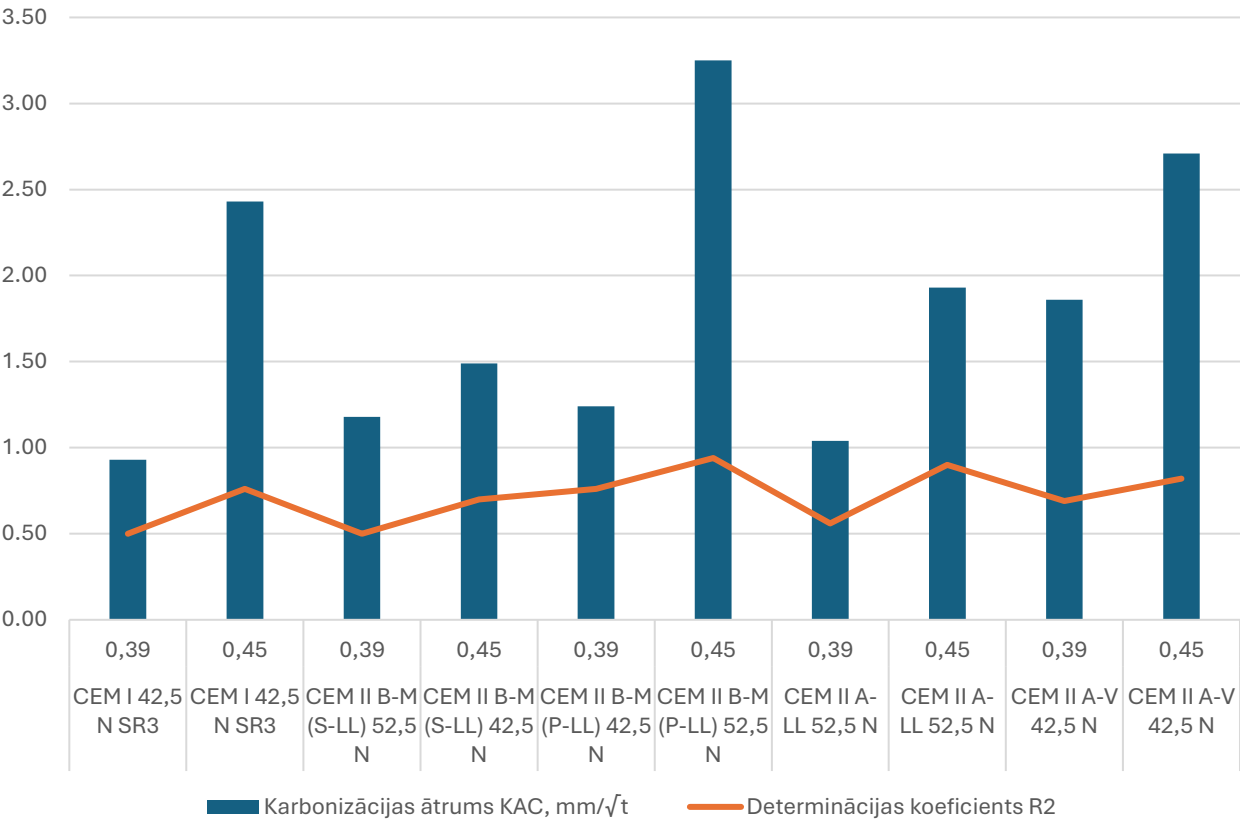


**NOTE 1** With normal concrete compositions, the carbonation depth at 70 days is expected to be  $\geq 4$  mm. A value lower than this indicates a concrete with high carbonation resistance, but the precision estimates given in Clause 10 are not applicable to carbonation rates based on very low carbonation depths.

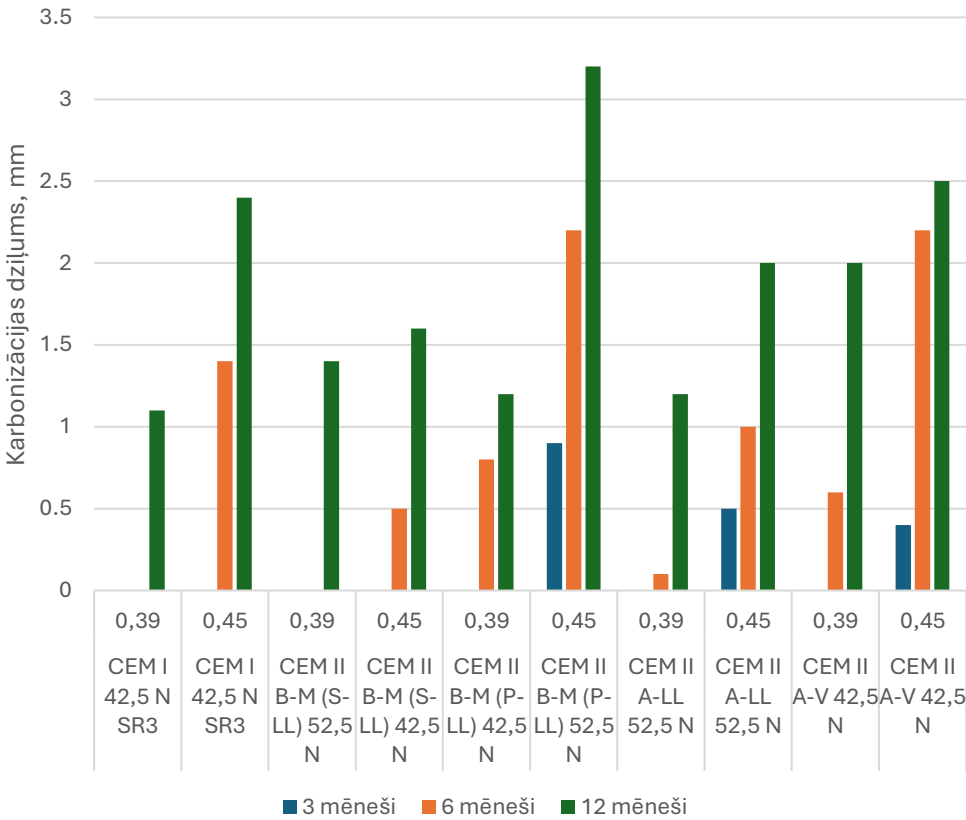


# BETONA KARBONIZĀIJA

Karbonizācijas ātruma koeficients , naturālā karbonizācija

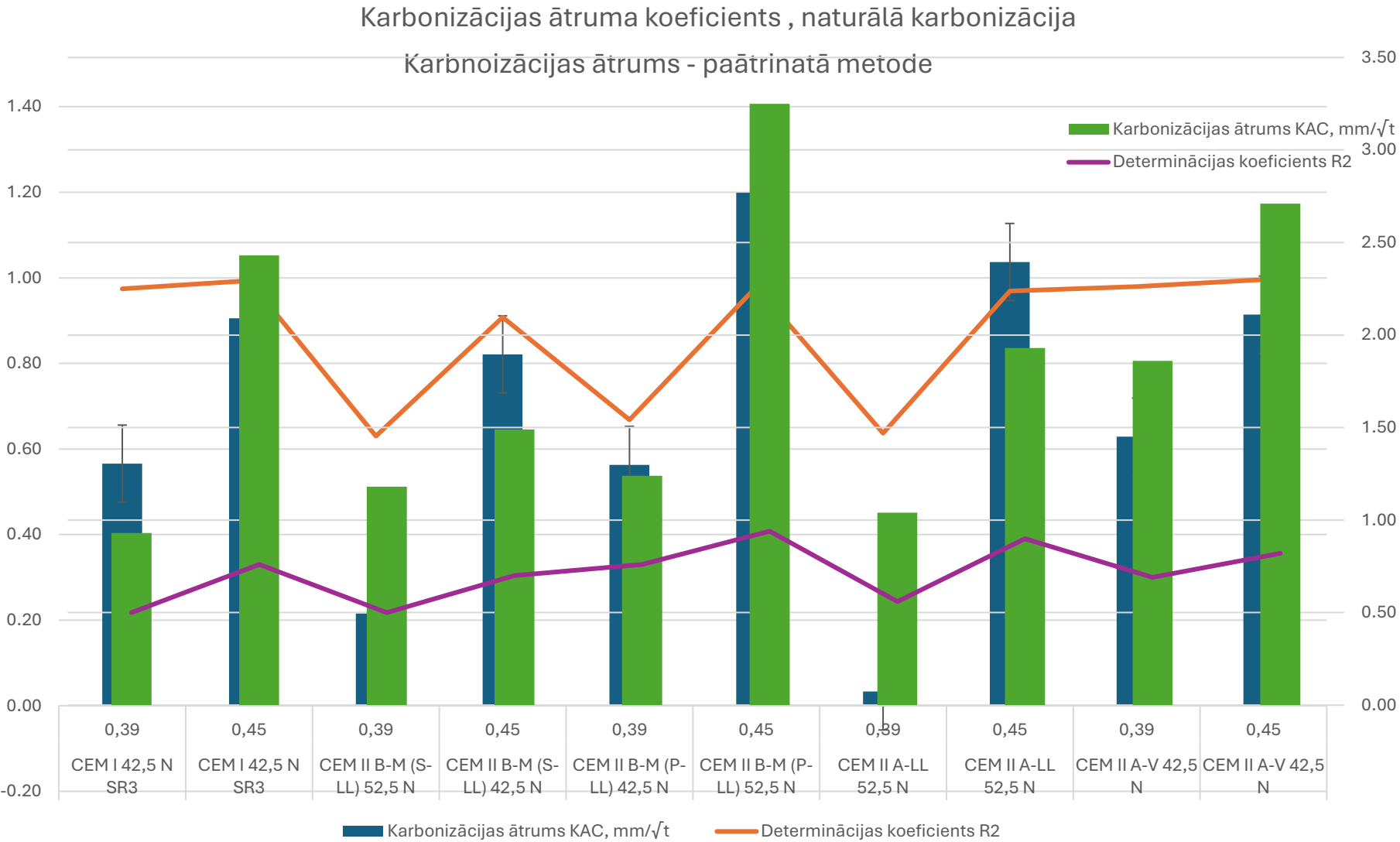


Karbonizācija dabīgos apstākļos

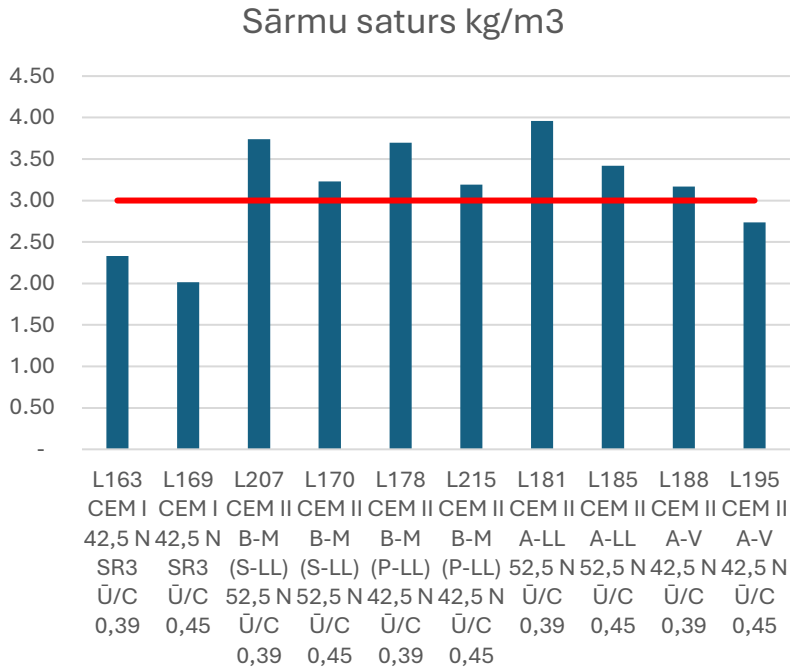


The carbonation depth should be measured at least after three months, six months and one year of storage. If the measured depth of carbonation is less than 5 mm at one year, the testing should be extended to two years.

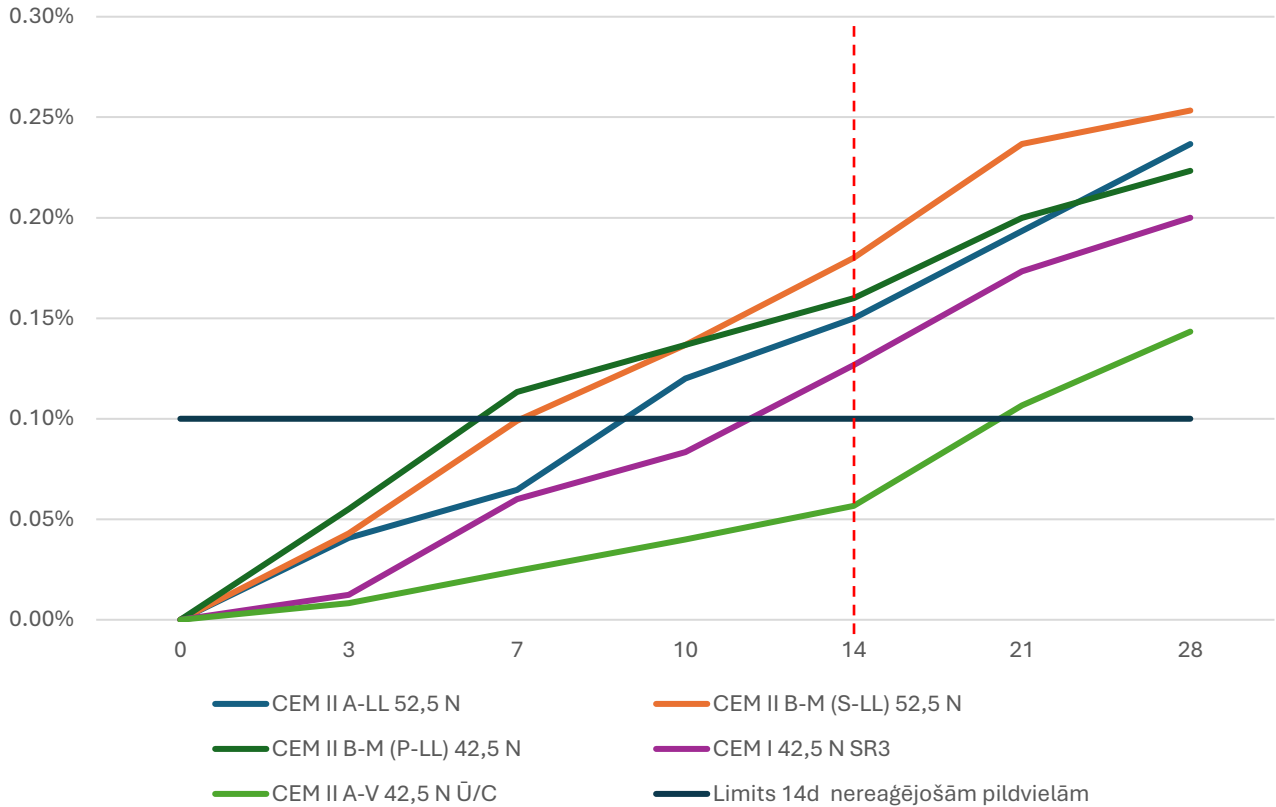
BETONA KARBONIZĀIJA



# SĀRMU SATURS UN ASR

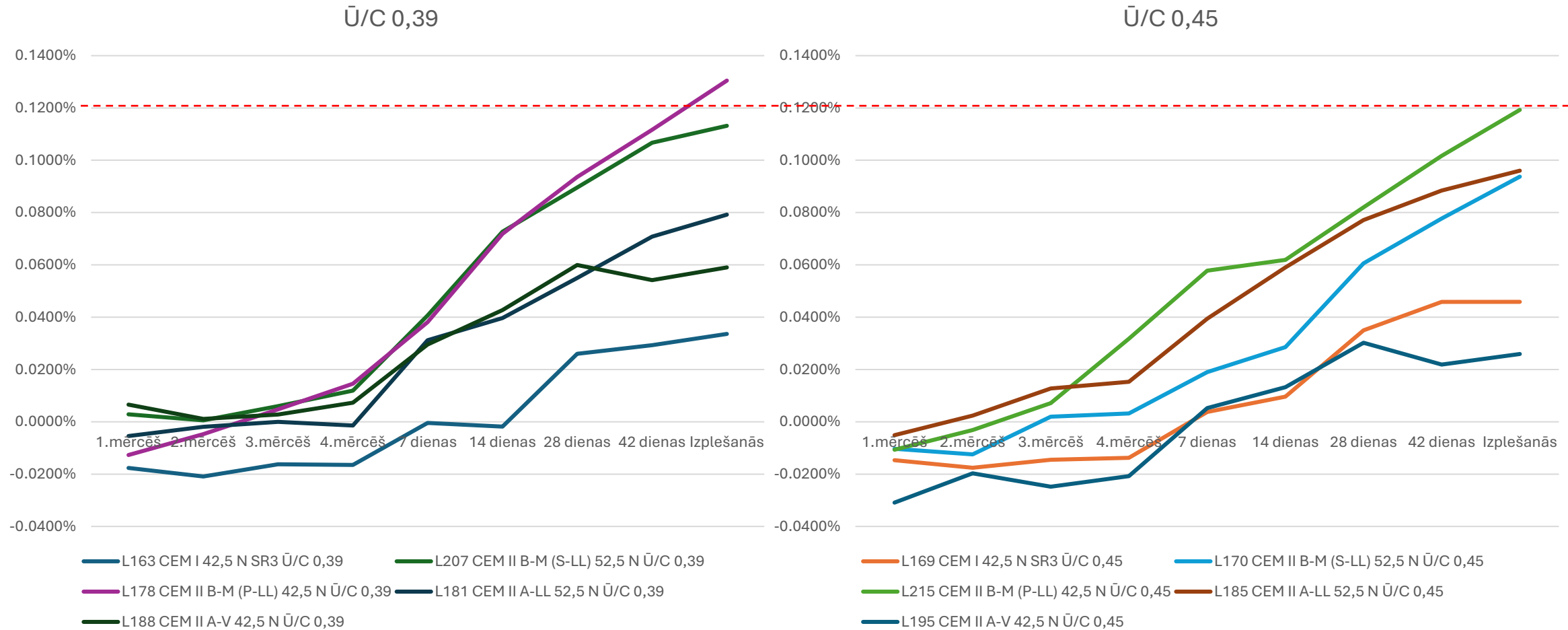


Paraugu izplešanās, atbilstoši ASTM C1260



\* ASR tests ar Eikefet granīta/gneisa – reaģējošām pildvielām

## SULFĀTIZTURĪBA



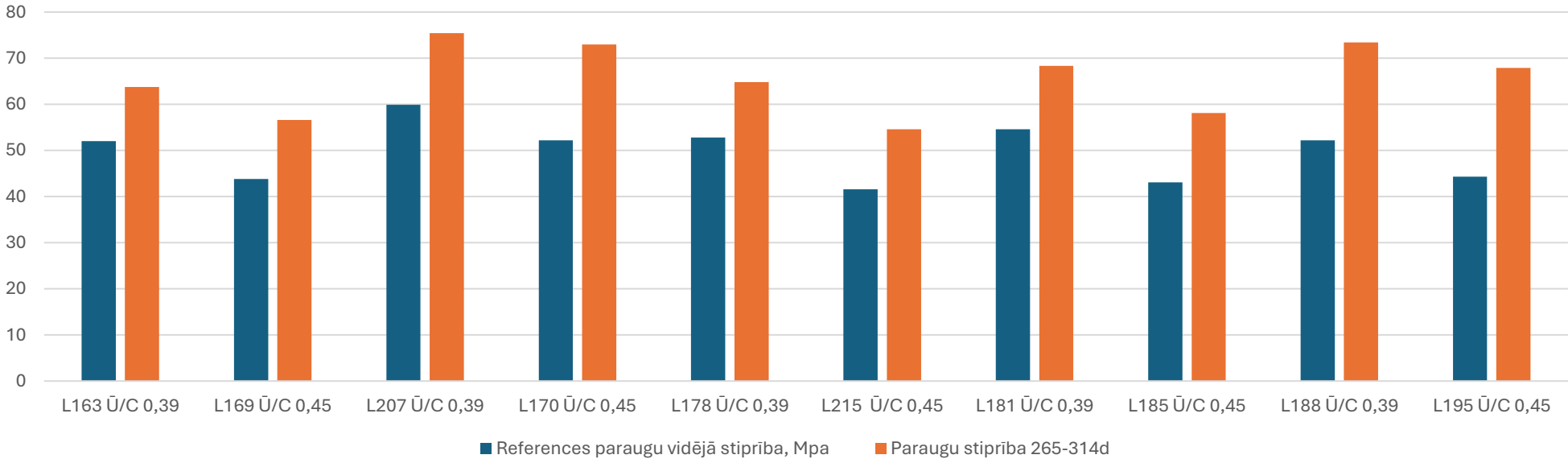
Šveices standarta testēšanas metode – noturība pret ārējo sulfātu ietekmi un etringāta veidošanos betonā.



# STIPRĪBAS ATTĪSTĪBA PĒC 28 DIENĀM

| Paraugu identifikācija                     | L163 Ū/C<br>0,39 | L169 Ū/C<br>0,45 | L207 Ū/C<br>0,39 | L170 Ū/C<br>0,45 | L178 Ū/C<br>0,39 | L215 Ū/C<br>0,45 | L181 Ū/C<br>0,39 | L185 Ū/C<br>0,45 | L188 Ū/C<br>0,39 | L195 Ū/C<br>0,45 |
|--------------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| References paraugu<br>vidējā stiprība, Mpa | 52               | 43,8             | 59,9             | 52,2             | 52,8             | 41,6             | 54,6             | 43,1             | 52,2             | 44,3             |
| Paraugu stiprība 260-<br>314d              | 63,7             | 56,6             | 75,4             | 73,0             | 64,8             | 54,6             | 68,3             | 58,1             | 73,4             | 67,9             |
| Pieaugums, %                               | 23%              | 29%              | 26%              | 40%              | 23%              | 31%              | 25%              | 35%              | 41%              | 53%              |

Betona paraugu stiprība



REZULTĀTU APKOPOJUMS UN IZVĒRTĒJUMS

Kompozītcementu izvērtējums pret references CEM I cementu pēc betona ilgmūžības parametriem

|                            | CEM I 42,5 N<br>SR3 | CEM II B-M<br>(S-LL) 52,5 N | CEM II B-M (P-LL) 42,5 N | CEM II A-LL<br>52,5 N | CEM II A-V<br>42,5 N |
|----------------------------|---------------------|-----------------------------|--------------------------|-----------------------|----------------------|
| Salizturība LVS 156-1      | ***                 | ***                         | ***                      | ***                   | ***                  |
| Salizturība CEN/TS 12390-9 | ***                 | ***                         | -                        | **                    | ***                  |
| Hlorīdu migrācija          | ***                 | ****                        | ****                     | ****                  | ****                 |
| Karbonizācija              | ***                 | ****                        | **                       | ***                   | ***                  |
| Sulfātizturība             | ***                 | ***                         | *                        | ***                   | ***                  |
| ASR                        | ***                 | ***                         | ***                      | ***                   | *****                |
| Kopējais reitings          | ***                 | ***(+)                      | **(-)                    | ***                   | ***(++)              |

# SECINĀJUMI

- Betoni ar  $\bar{U}/C$  0,39 kopumā uzrāda ļoti labas ilgmūžības īpašības un korelācijas starp dažādiem parametriem mazinās, jo betona izturība ir ļoti augsta gan ar portlandcementu, gan ar lielāko daļu no testētajiem kompozītcementiem.
- Šī darba ietvaros neizdevās iegūt korelāciju starp abām betona salizturības testēšanas metodēm. Betona stiprības zudumu metode ir mazāk jūtīga pret kompozītcementu ietekmi uz betona salizturības parametriem.
- Salizturībai ar virsmas masas zudumu metodi – rezultāti korelē nevis ar betona  $\bar{U}/C$  attiecību, bet gan ar ūdens/cementējošo minerālu attiecību.
- Divi no četriem testētajiem kompozītcementiem CEM II/B-M (S-LL) 52,5 N un CEM II/A-V 42,5 N uzrāda vai nu līdzvērtīgas, vai pat labākas atsevišķas betona ilgmūžības īpašības nekā references izmantotais portlandcements, tāpēc šos cementus var rekomendēt izmantot infrastruktūras būvēs ar projektēto kalpošanas laiku 100 gadiem.
- Šajā darbā iegūtos rezultātus var izmantot par pamata datubāzi betona ilgmūžības parametriem ar dažādiem cementiem, un turpināt citu cementu novērtēšanu pēc tādas pašas testēšanas programmas.



Baustoff leben



# Osvalds Trofimovs

PREfabrica

No rasējuma līdz objektam: kā samazināt  
vides ietekmi dzelzsbetona elementiem

**BETONA KONSTRUKCIJAS AR SAMAZINĀTU VIDES NOSPIEDUMU**

**Latvijas Betona savienības 33. zinātniski tehniskā konference**

**RĪGA 2025**

**IZMAKSAS**

**CO<sub>2</sub>**

**IESPĒJAS**





Projektēšana → Ražošana → Transports →  
Montāža → Eksploatācija





## Projektēšana

- EPD datu izmantošana
- Standartizācija
- Optimizācija?
- 3D modelēšana
- Sadarbība





## Ražošana

- Vietējās izejvielas
- Materiālu aizvietotāji
- Atkritumu šķirošana un atkārtota izmantošana
- Energoefektīvas telpas un infrastruktūra





## Transports un montāža

- Optimizēts kravu plāns – mazāk reisu.
- Montāžas plānošana = mazāka dīkstāve, mazāk tehnika objektā.
- Pagaidu konstrukciju atkārtota izmantošana.





**Ekspluatācija**

- Ilgmūžība
- Zema apkope
- Atkārtota izmantošana





**EVERY CHAMPION WAS  
ONCE A CONTENDER WHO  
REFUSED TO GIVE UP**

**ROCKY BALBOA**



**OSVALDS TROFIMOV**

**28665930**

**OSVALDS@PREFABRICA.LV**







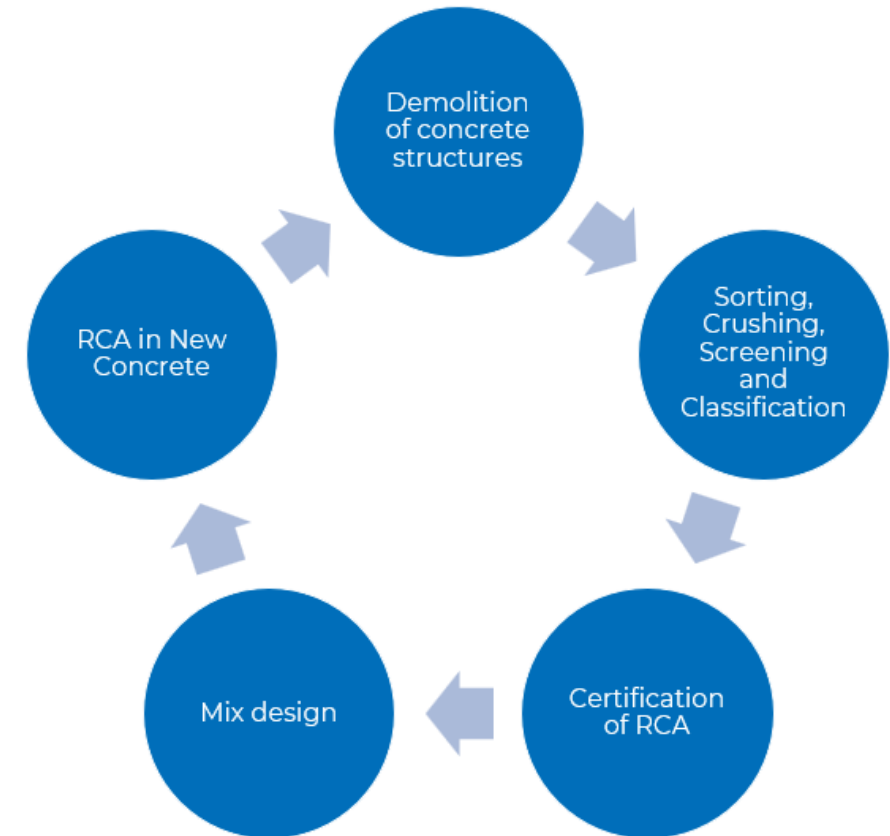
# **New admixture technology for re-using recycled concrete aggregates in concrete production**

Latvian Concrete Association's 33rd  
Scientific and Technical Conference

Sven-Henrik Norman Mapei

# Background

- **Depleting resources** of high quality natural sand and aggregate
- **Sustainability** focus
  - EU initiatives
  - Corporative initiatives
- **Circular economy**
  - Cost driven
  - Carbon footprint driven
- **Advancements**
  - Mechanical equipment & process
  - Industry standards
  - **Chemical admixtures**
    - **Demanding SCM**
    - **Demanding Aggregates**



# Challenges when using RCA in concrete

- Higher Water absorption than natural aggregates.
- Uncertainties regarding Water Absorption -Test methods based on Natural aggregates.
- Accelerating air when using very high dosages of RCA ( >50%).
- Rapid slump loss if WA is not mitigated.
- Loss of compressive strength if air content is not controlled.
- Fine fraction is particularly challenging.
- To counter Water absorption, normal PCE admixtures needs to be dosed in such high quantities that stability becomes an issue.
- When increasing free water and wcr is fixed, increased used of cement leads to higher cost and carbon footprint.



**Sorption**  
Natural 0,3-0,9%  
RCA 6-8%

The diagram features a background of several interlocking metal gears. Overlaid on this is a flowchart with four main components: a blue rounded rectangle at the top left, a blue rounded rectangle in the center, a blue rounded rectangle at the bottom, and a light blue circle on the right. Arrows indicate a flow from the top rectangle to the center, from the center to the bottom, and from the circle to the bottom.

**Water/Cement  
ratio?**

**Strength?  
Durability?  
Workability?**

**Air  
content  
and  
quality?**

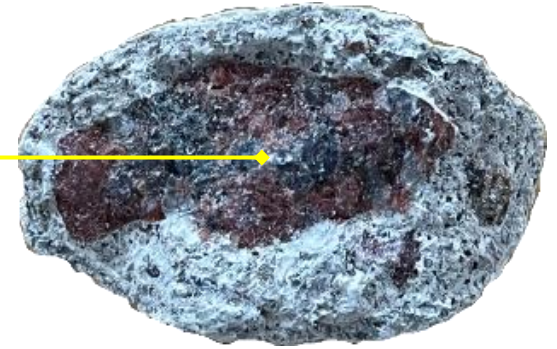
# AbSorption



**Natural Coarse Aggregates**  
(Water absorption 0,3%)  
-"Normal" water demand



**Recycled Concrete Aggregates**  
(Water absorption 6-8%)  
-High Water demand

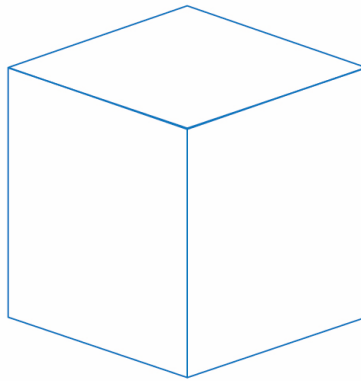




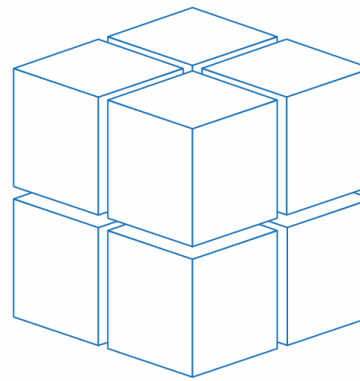
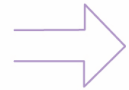
# AdSorption

**SPECIFIC SURFACE AREA** (idealized geometric model)

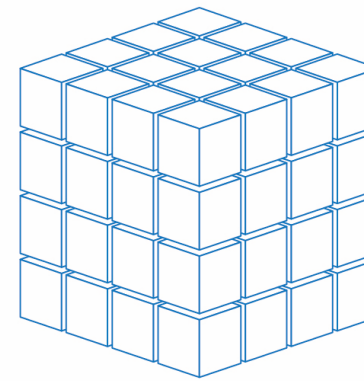
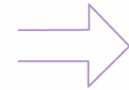
$$SSA_n = SSA_1 \times n^{1/3}$$



One weight unit  
before first fracture  
**SSA = 1**



Same weight unit  
split into 8 pieces  
**SSA = 2**



Same weight  
unit split into 64 pieces  
**SSA = 4**

# Our solution: Re-Con AGG a Microphase retention system

- Developed for challenging raw materials:
  - Clay bearing sand
  - Manufactured sand with high fines content and high SSA fines (e.g. Free mica)
  - **Recycled Concrete Aggregates RCA**
  - Binders-SCM





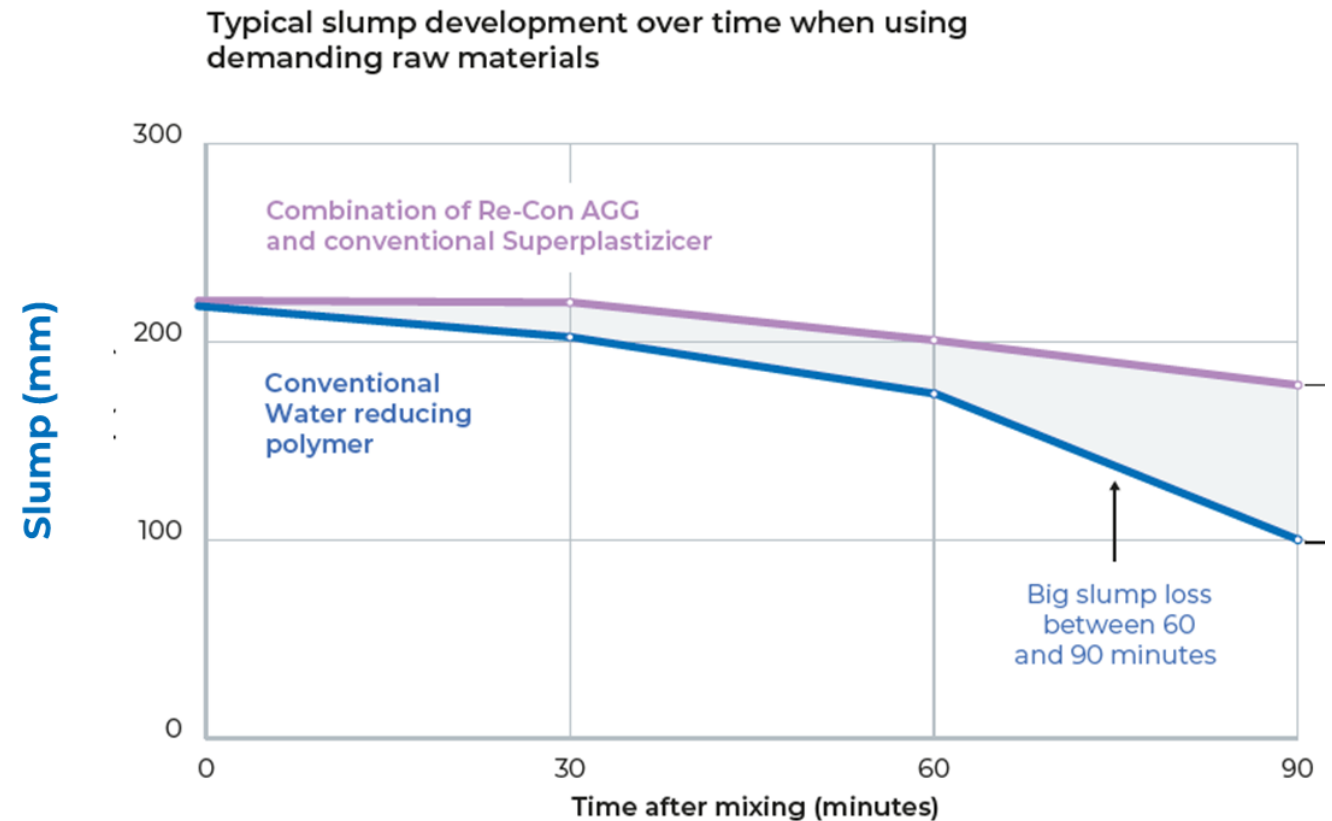
# Our solution: Re-Con AGG a Microphase retention system

- Phase 1: **Sorption control by Initial shielding.**
  - Prevents large parts of water and normal PCE admixtures to be adsorped or absorbed.
- Phase 2: **Adaptive polymer structure.**
  - Increased alkalinity of the microphase releases polymers acting on cement grains giving additional slump retention to complementary PCEs in the mix design.



# Our solution: Microphase retention system

- Proven results with positive effects on sorption control, thereby letting the free water and PCE admixtures stay in the microphase for a longer time.
- Extended workability of concrete with highly demanding raw materials
- **In addition:** Proven results with **reducing the air content** at very high dosages of RCA



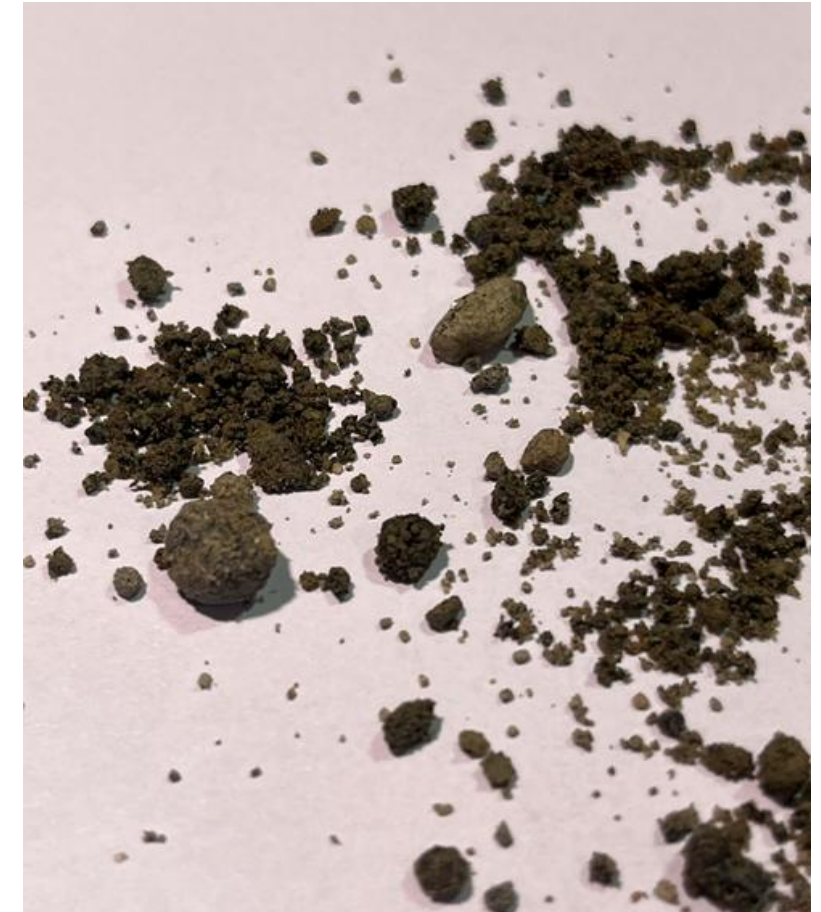
# Specific project example 1

- Norwegian project MILBET:  
**Miljøvennlige Betongløsninger**
- Project owner: Nordland Betong
- Main target: Producing concrete with more recycled aggregate
- Recycled concrete aggregates (RCA):
  - A waste stream in own production of paving stone
  - A waste stream from demolished Bodø Airport





# 0/4 mm RCA



# 4/8 mm RCA





## 8/22 mm RCA





# Mix design – testing 50% RCA

- C30/37
- 337 kg/m<sup>3</sup> Std. FA (CEM II/B-M 42.5R)
- w/c = 0.52
- Free fall mixer
- Aggregates:
  - **Reference:** 100% natural
  - **50% RCA:** 50% 0/8 mm RCA + 50% 8/22 mm RCA
- Admixture:
  - Superplasticizer (Dynamon)
  - Microphase retention system (Re-Con AGG 90)

# Slump/spread

| Mix ID                        | Aggregate type        | Admixture dosage [% cwt]           | Slump/spread [mins. &mm] |         |         |         |        |
|-------------------------------|-----------------------|------------------------------------|--------------------------|---------|---------|---------|--------|
|                               |                       |                                    | 0'                       | 30'     | 60'     | 90'     | 120'   |
| 1 - REF                       | 100% natural          | 0.6% Dynamon                       | 230/520                  | 200/370 | 190/320 | 120/210 | 80/200 |
| 2 – 50% RCA                   | 50% RCA + 50% natural | 0.9% Dynamon                       | 210/350                  | 100/210 | x       | x       | x      |
| 3 – 50% RCA med Re-Con AGG 90 | 50% RCA + 50% natural | 0.9% Dynamon<br>0.5% Re-Con AGG 90 | 230/570                  | 200/390 | 200/340 | 140/220 | 50/200 |

# Directly after mixing



Reference – 100% natural



50% RCA – without Re-Con AGG 90



50% RCA – with Re-Con AGG 90



## 30 minuted after mixing



Reference – 100% natural



50% RCA – without Re-Con AGG 90



50% RCA – with Re-Con AGG 90

# 90 minutes after mixing



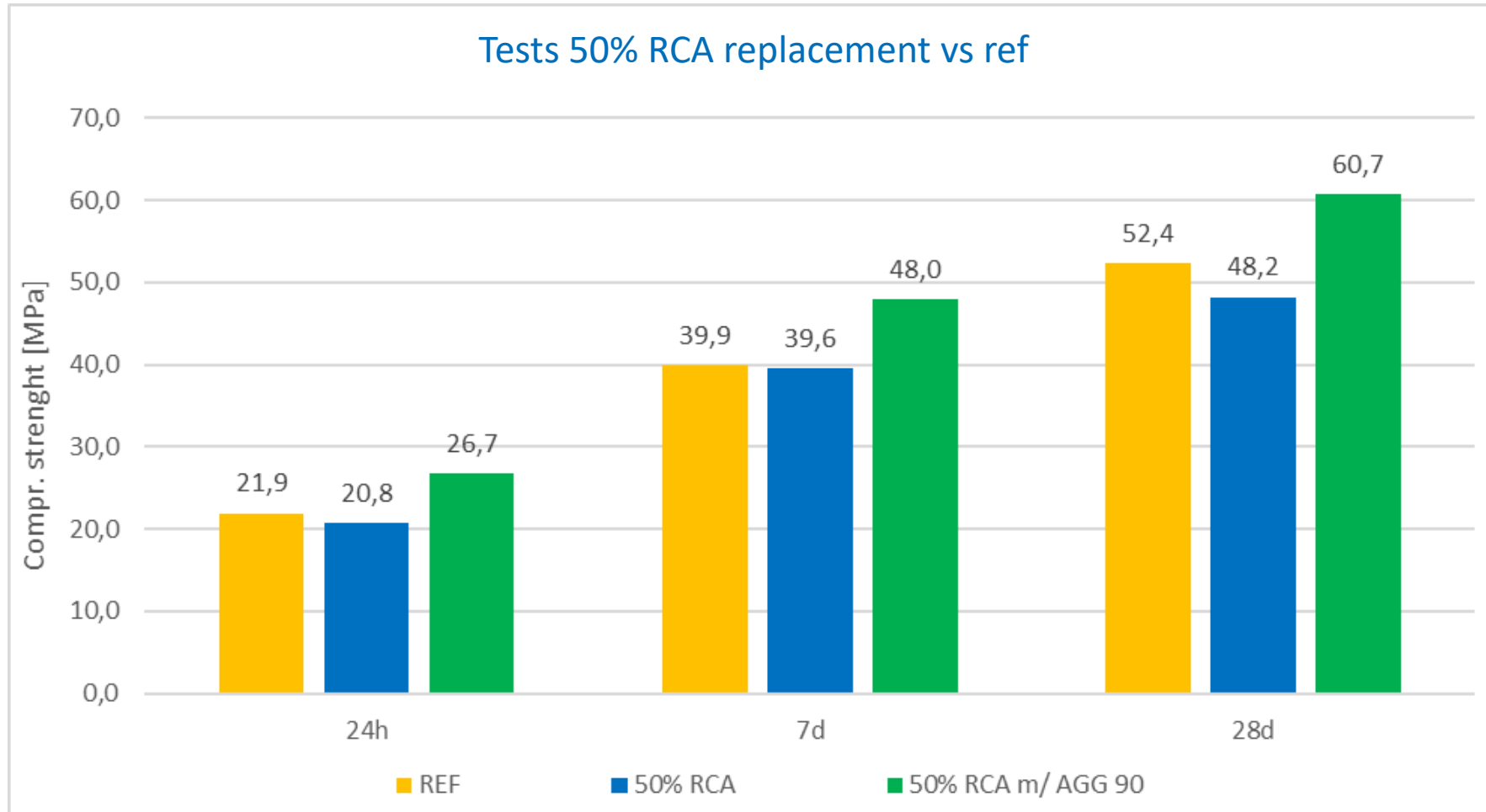
Reference – 100% natural



50% RCA – with Re-Con AGG 90

((50% RCA – without Re-Con AGG 90))

# Compressive strength





# Mix design – tests with 84% RCA

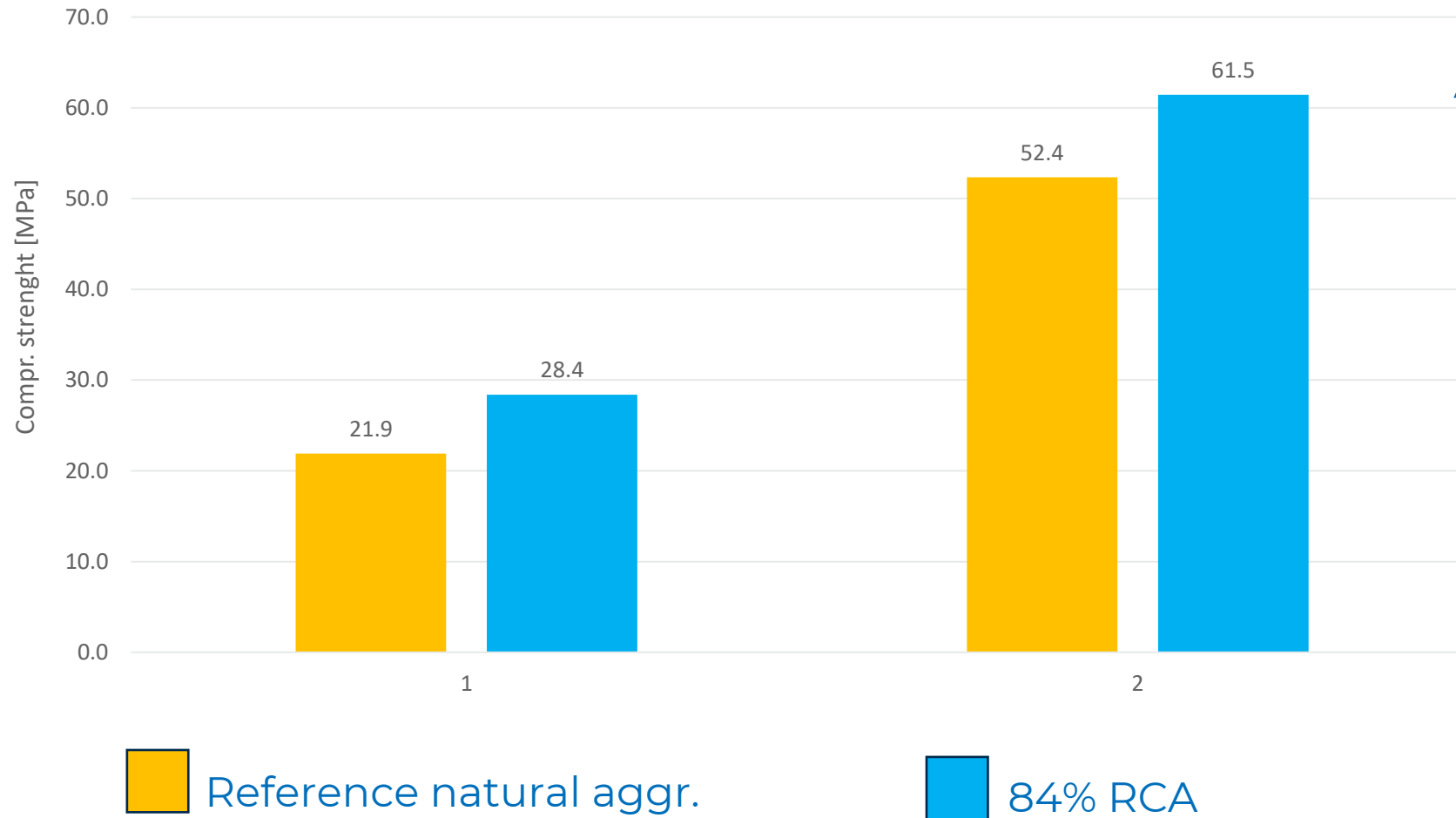
- C30/37
- $w/c = 0.52$
- Free fall mixer
- Aggregates:
  - **Reference:** 100% natural (Norstone)
  - **84% RCA:** 75% 0/8 mm RCA + 100% 8/22 mm RCA
- Admixtures:
  - Superplasticizer (Dynamon)
  - Microphase retention system (Re-Con AGG 90)
- 385 kg/m<sup>3</sup> Std. FA (CEM II/B-M 42.5R)

# Slump/spread

| Mix ID      | Aggregate type        | Admixture dosage [%of cwt]              | Slump/Spread [mins & mm] |         |         |         |         |
|-------------|-----------------------|-----------------------------------------|--------------------------|---------|---------|---------|---------|
|             |                       |                                         | 0'                       | 30'     | 60'     | 90'     | 120'    |
| 1 - REF     | 100% natural          | 0.6% Dynamon                            | 230/520                  | 200/370 | 190/320 | 120/210 | 80/200  |
| 2 – 84% RCA | 84% RCA + 16% natural | 1.75% Dynamon<br>0.83% Re-Con<br>AGG 90 | 225/580                  | 225/570 | 200/400 | 180/310 | 140/230 |

# Compressive strength and Air life

Tester med 84% RCA



Air content

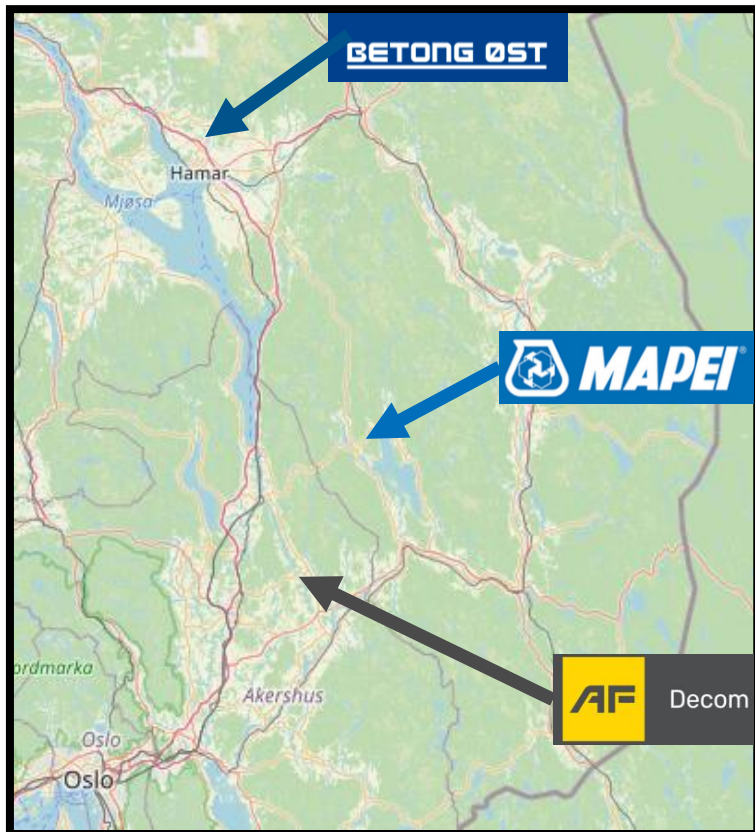
Ref: **0,5%-1,2%** directly after mixing, **2,0%-2,6%** after 120 min

84% RCA w. Dynamon & Re-Con AGG 90: **1,2%** after 120 min



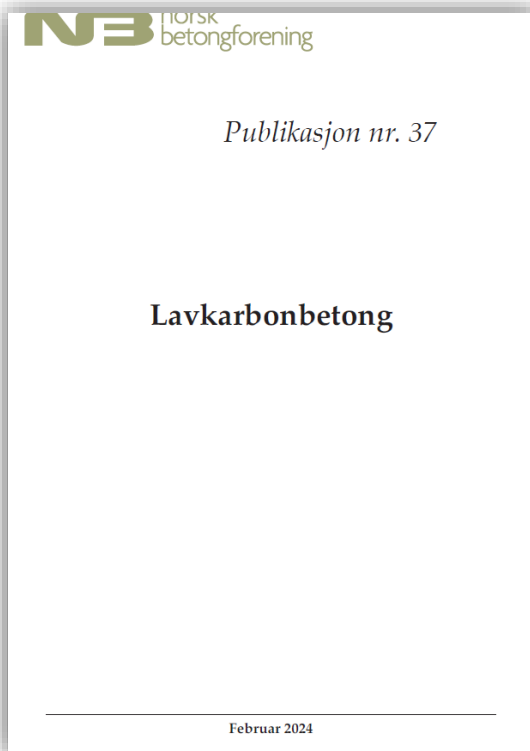
## Project example 2

- Mapei R&D center extension by 1000m<sup>2</sup>
- R&D focused on sustainable concrete solutions



# What is possible?

- Slab on ground indoor
- We decided to go as far as possible with use of recycled aggregates
- We decided to aim for GWP levels at Low Carbon concrete Pluss acc. to Norwegian guidelines.



| Fasthetsklasse <sup>1)</sup> og lavkarbonklasse                                                   | B20 <sup>3)</sup> | B25 <sup>3)</sup> | B30 | B35 | B45 | B55 | B65 |
|---------------------------------------------------------------------------------------------------|-------------------|-------------------|-----|-----|-----|-----|-----|
| Maksimalt tillatt klimagassutslipp, GWP-total [kg CO <sub>2</sub> -ekv. pr m <sup>3</sup> betong] |                   |                   |     |     |     |     |     |
| Bransjereferanse <sup>4)</sup>                                                                    | 200               | 210               | 245 | 270 | 300 | 310 | 330 |
| Lavkarbon B                                                                                       | 180               | 190               | 225 | 240 | 270 | 280 | 300 |
| Lavkarbon A                                                                                       | 160               | 170               | 200 | 210 | 220 | 230 | 240 |
| Lavkarbon Pluss <sup>2)</sup>                                                                     | 135               | 140               | 150 | 160 | 170 | 180 | 190 |
| Lavkarbon Ekstrem <sup>2)</sup>                                                                   | 100               | 105               | 110 | 120 | 130 | 140 | 150 |

# Choice of raw materials

## Aggregates:

- Washed recycled Excavated materials NES Miljøpark, 0 – 16 mm
- Recycled crushed concrete (RCA), 16 – 22 mm (from Rimol)
- SIGS-slagg from Eramet Norway in Porsgrunn, 10 – 22 mm

## Binder:

- Schwenk Lavvarmesement (CEM III/B)
- Elkem Microsilica

## Admixtures:

- Local Dynamon product
- Re-Con AGG 90
- Mapecrete SRA-N
- Expancrete





# Aggregates

## 0-16 mm

Washed recycled  
excavated mtrl



## 16-22 mm

RCA



## 10-22 mm

SIGS-slag





# Concrete mix design

2 mix designs: RCA or Slag as coarse aggregates

## B35 M45 D22 – 230 mm Lavkarbon Pluss with 100 % Recycled aggregates

| Materiale          |                           | Prop    | Masse (kg)     |
|--------------------|---------------------------|---------|----------------|
| 1183               | Resirkulert tilslag 16/22 | 20,00 % | 322,3          |
| 1699               | Nes vasket 0-16           | 80,00 % | 1 383,3        |
| <b>Sum tilslag</b> |                           |         | <b>1 705,7</b> |
| 2035               | Schwenk CemIII/B          | 97,00 % | 377,5          |
| 3001               | SILIKA                    | 3,00 %  | 11,7           |
| 6014               | SX-23                     | 0,48 %  | 1,9            |
| 6125               | SRA-N                     | 1,00 %  | 3,9            |
| 6126               | EXPAN                     | 4,85 %  | 18,9           |
| 6600               | Re-Con AGG 90             | 0,50 %  | 1,9            |
|                    | Vann                      |         | 180,0          |
|                    | Luft                      | 2,00 %  | 0,0            |
| <b>Totalt</b>      |                           |         | <b>2 301,5</b> |

| Materiale          |                          | Prop    | Masse (kg)     |
|--------------------|--------------------------|---------|----------------|
| 1188               | SIGS Eramet Herøya 10/22 | 25,00 % | 441,0          |
| 1699               | Nes vasket 0-16          | 75,00 % | 1 298,4        |
| <b>Sum tilslag</b> |                          |         | <b>1 739,3</b> |
| 2035               | Schwenk CemIII/B         | 97,00 % | 377,5          |
| 3001               | SILIKA                   | 3,00 %  | 11,7           |
| 6014               | SX-23                    | 1,12 %  | 4,3            |
| 6125               | SRA-N                    | 1,00 %  | 3,9            |
| 6126               | EXPAN                    | 3,88 %  | 15,1           |
|                    | Vann                     |         | 180,0          |
|                    | Luft                     | 2,00 %  | 0,0            |
| <b>Totalt</b>      |                          |         | <b>2 331,9</b> |

# Flooring placement

2 days.

2 areas polished and sealed.

Office area added system: Mapefloor Comfort.

Mapecrete System/Dønn Fugefri:

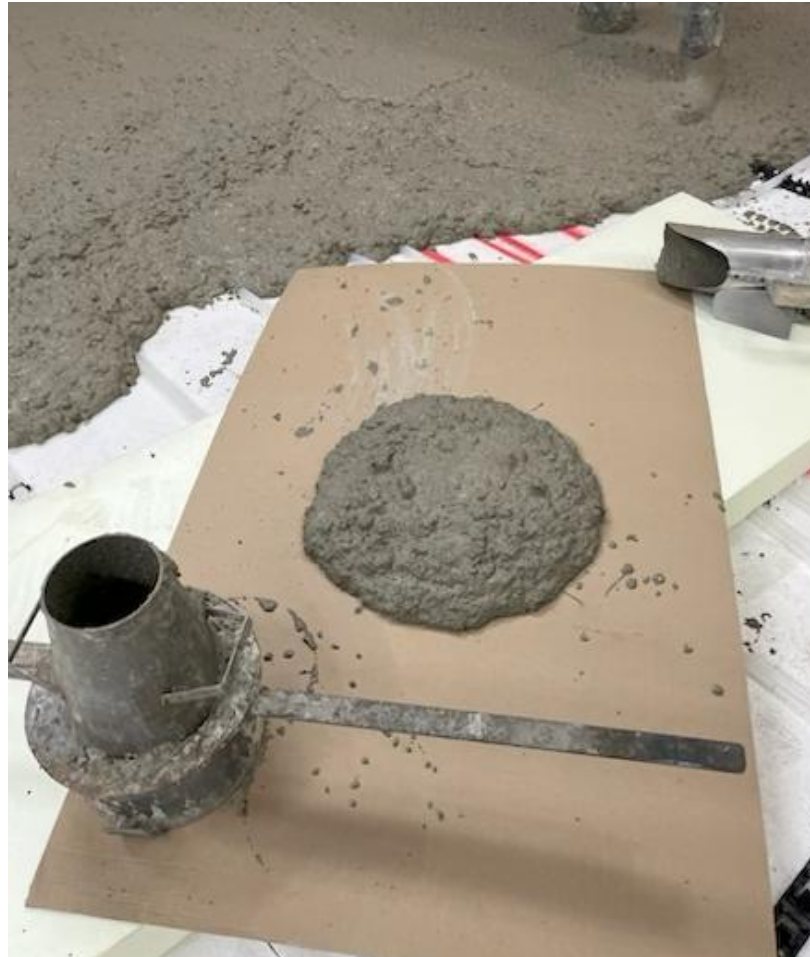
- Fibre Reinforced Concrete
- Shrinkage Reducing Agent
- Expanding agent



# Challenge?

Low Carbon concrete Plus  
100% recycled aggregates  
30 kg/m<sup>3</sup> Steel fiber  
1 hour transport

..Rather challenging  
normally!



First load on site:  
Slump: 230 mm  
Spread: 400 mm

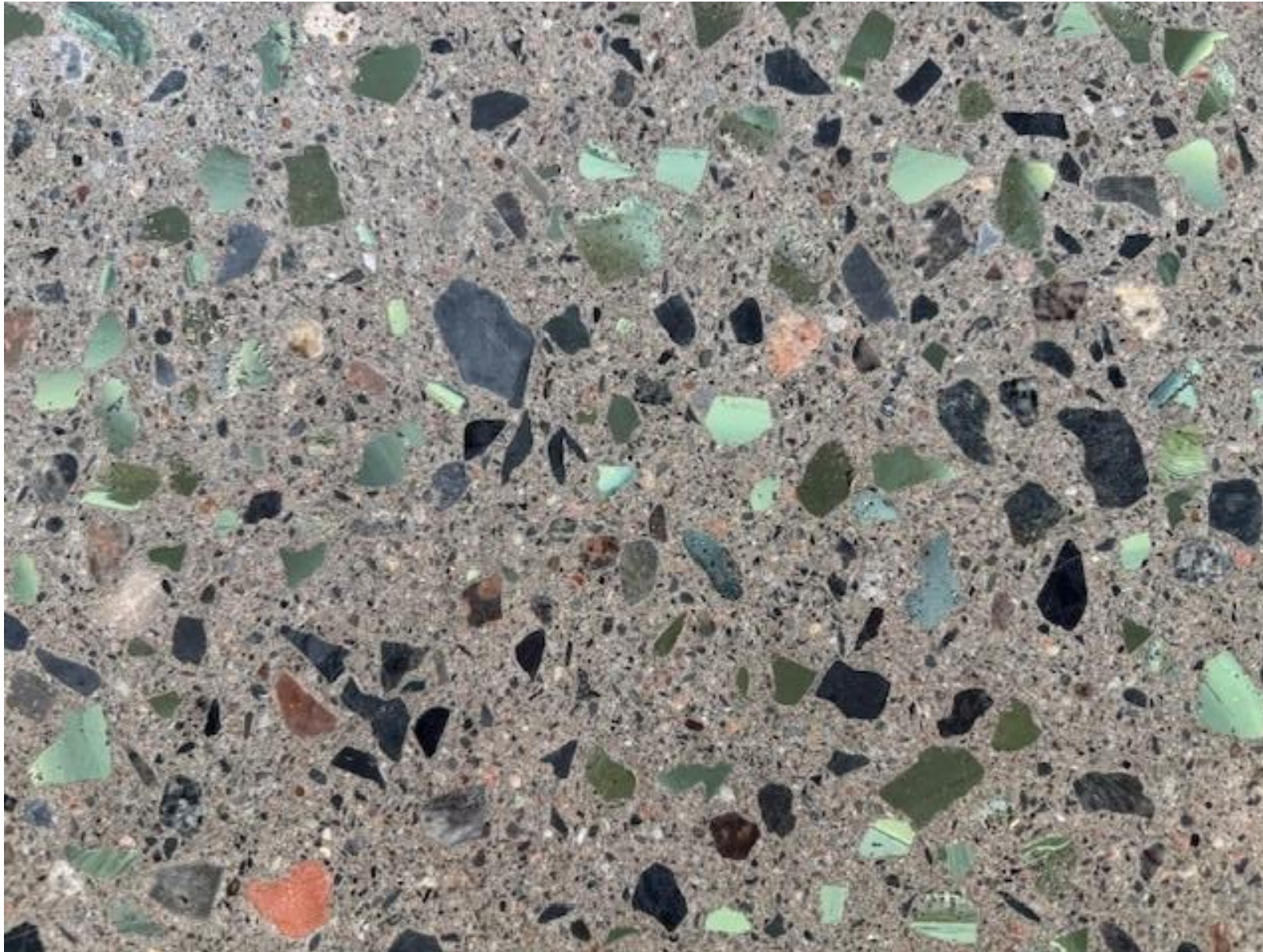
145m<sup>3</sup> pumped  
without issues

**“Re-Con AGG 90  
was the deciding  
factor for constant  
workability”**

-project team and  
material supplier



# Green concrete



$GWP_{total} (A1 - A3) =$   
**157,3 kg CO<sub>2</sub>/m<sup>3</sup>**  
(concrete with  
16-22 RCA)

$GWP_{total} (A1 - A3) =$   
**158,6 kg CO<sub>2</sub>/m<sup>3</sup>**  
(concrete with  
16-22 SIGS slag)

(including ALL  
admixtures,  
not reinforcement)

# Hardening

Schwenk Lavarmesement contains 70 % slag.

Daily temperatures appr. +10 °C. Night temperatures outside sometimes -3 °C.

Sample cubes taken 24 April and 28. april. Stored on site and in lab (+20 °C)

Compressive strength meets B35 with good margin (required is B35;  $f_{ck,28} \geq 45 \text{ N/mm}^2$ ).

| Age     | 24.04.25 (stored on site)<br>Compr.str. (N/mm <sup>2</sup> ) | 28.04.25 (stored in lab)<br>Compressive strength (N/mm <sup>2</sup> ) |
|---------|--------------------------------------------------------------|-----------------------------------------------------------------------|
| 24 hrs  | 2,8                                                          | 13,0                                                                  |
| 4 days  | 16,7                                                         |                                                                       |
| 7 days  | 30,7                                                         | 39,7                                                                  |
| 28 days | 52,0                                                         | 58,2                                                                  |
| 56 days | 59,0                                                         | 59,5                                                                  |
| 91 days | 68,0                                                         | 65,5                                                                  |

# Summary and further research

- Recycled Concrete Aggregates can be challenging for workability
- In very high dosages, air content can accelerate, affecting strength
- Re-Con AGG Microphase retention system admixture has shown positive effects on these 2 challenge areas
- *Further research is needed to understand the Sorption mechanisms even better*
- *Carbon footprint could be lowered even further by accelerated recarbonation of calcium compounds in RCA*







# **Betona plātņu klimata nospieduma samazināšana, pielietojot disperso tērauda stiegrojumu**

**PrīmX® D&B Risinājumi**



**Valters Sējāns**  
Projektēšanas Projektu Vadītājs  
Primekss

# PrīmX® - pielāgoti efektīvi inženiertehniskie risinājumi



**Primekss – Izpētes,  
projektēšanas un  
būvniecības uzņēmums**



**Ziemeļeiropas  
lielākais privātais  
betona R&D centrs**



**Testēšanā balstīta  
projektēšana– ar  
vairāk nekā 20 pilna  
mēroga testiem**

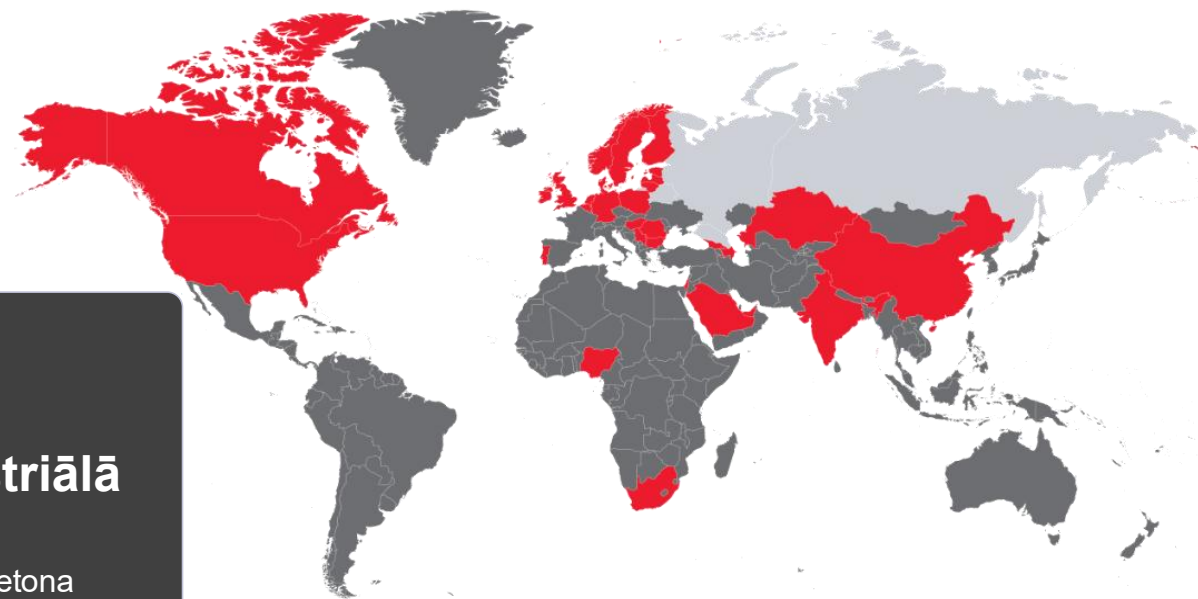


**PrīmX® inovācijas ir  
guvušas atzinību  
pasaules mērogā**

CERTIFIED  
ISO 9001 - ISO 14001  
ISO 45001 - ISO 50001



# Globāli ieviesta tehnoloģija



## Datu Centri

Datu centri ar kritiski svarīgām sistēmām, kurām nepieciešama izcila līdzenuma un nestspējas kvalitāte



## Gigarūpnīcas

Liela mēroga ražošanas rūpnīcas ar augstām konstrukciju veikspējas prasībām



## Civilā/industriālā būvniecība

Izturīga, bezšuvju betona tehnoloģija, izstrādāta civilajām un industriālajām būvēm



## Loģistikas centri

Optimizēti risinājumi smagajai tehnikai un automatizētām noliktavu sistēmām



## Smagā Rūpniecība

Projektēts ekstrēmām slodzēm

Plaši ieviesta tehnoloģija industriālajos objektos visā pasaulē





# Tērauda šķiedru dispersi armēts betons (SFRC)

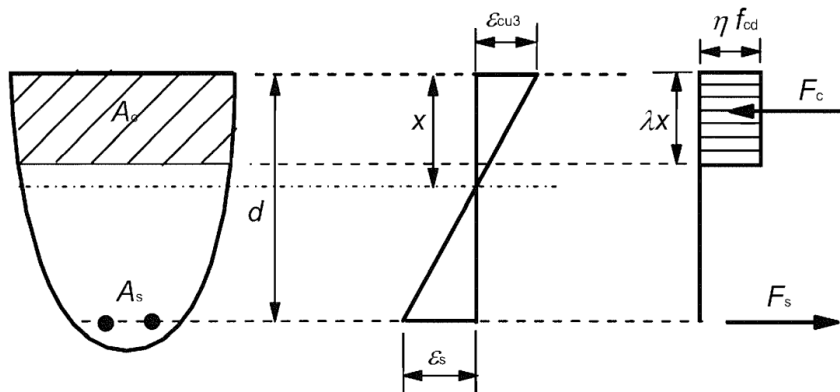
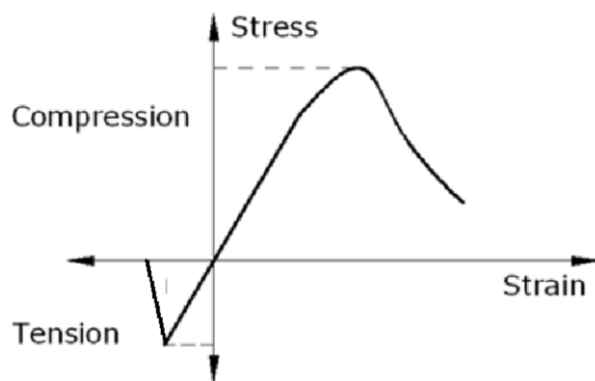


Figure 3.5: Rectangular stress distribution



## O.3 General approach for fibre concrete with or without bar reinforcement

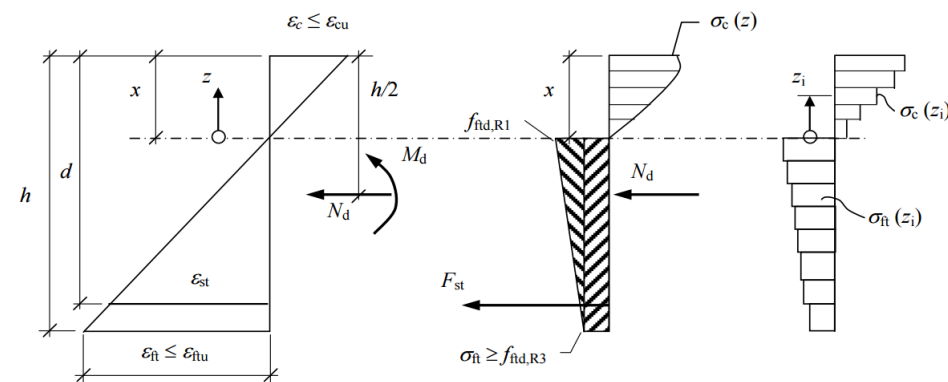
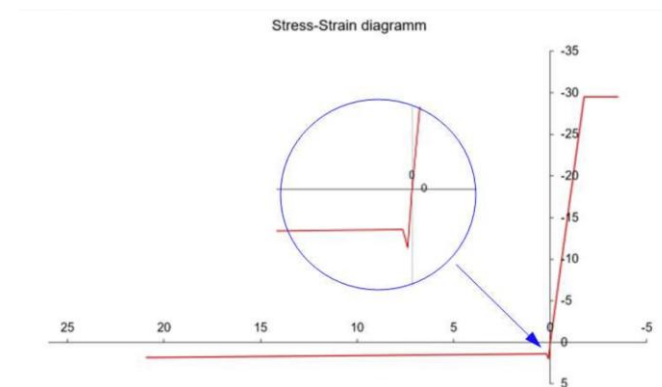


Figure O.3 — Strain and stress distribution for fibre concrete with or without bar reinforcement



# SFRC aprēķini/modelēšana

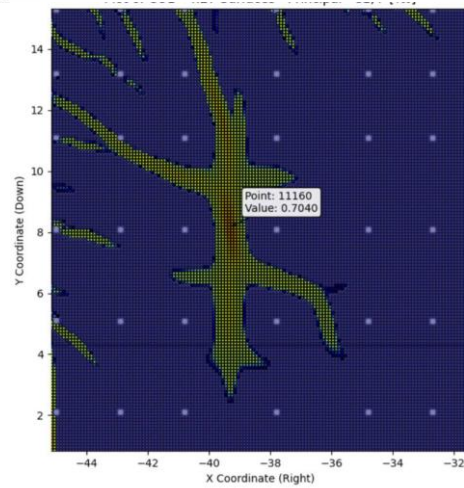
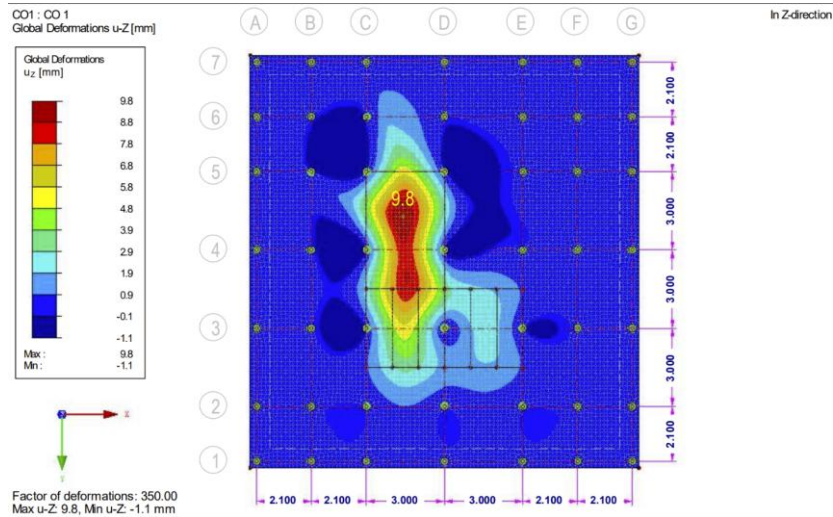


Fig. 14. Corresponding crack layout

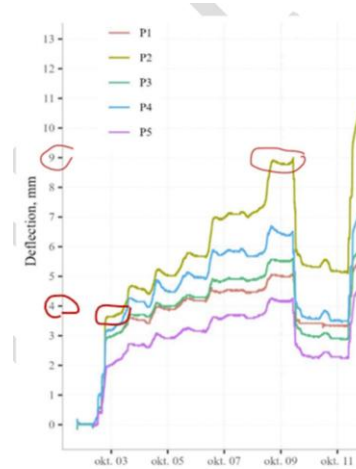


Fig. 15. FST deflection curve

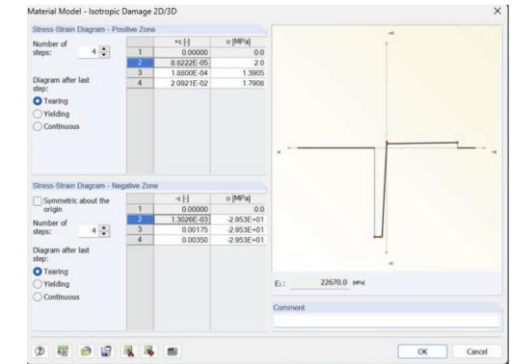


Table 4.1. Crack widths (mm) measured by microscope on the bottom surface of Slab 1

| Crack name and position | Time             |                  |                  |                  |                  |                  |                  |
|-------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                         | 02.10.2023 08:00 | 08.10.2023 12:00 | 09.10.2023 09:00 | 09.10.2023 16:00 | 11.10.2023 08:00 | 11.10.2023 12:30 | 12.10.2023 07:30 |
| B01-A                   | 0.38             | -                | 0.88             | 0.82             | 0.8              | 0.81             | -                |
| B01-B                   | 0.35             | 0.71             | -                | -                | -                | 0.62             | -                |
| B01-C                   | 0.18             | -                | 0.58             | 0.52             | 0.5              | 0.52             | 0.53             |
| B01-D                   | 0.14             | -                | -                | 0.53             | -                | 0.56             | -                |
| B01-E                   | 0.16             | -                | -                | 0.72             | -                | 0.56             | -                |
| B01-F                   | 0.05             | -                | -                | -                | -                | 0.51             | -                |
| B01-G                   | -                | -                | 0.46             | 0.28             | -                | 0.42             | -                |
| B02-A                   | 0.55             | -                | 1.08             | 0.95             | 0.9              | 0.99             | -                |
| B02-B                   | 0.45             | -                | -                | 0.65             | -                | 0.67             | -                |
| B02-C                   | 0.30             | -                | 0.74             | 0.65             | -                | 0.72             | 0.72             |
| B02-D                   | 0.32             | -                | -                | 0.47             | 0.5              | 0.51             | -                |
| B02-E                   | 0.45             | -                | -                | 0.24             | -                | 0.20             | -                |
| B02-F                   | 0.32             | -                | -                | 0.08             | -                | 0.10             | -                |
| B11-1                   | -                | 0.69             | 1.02             | 0.80             | 0.57             | 0.79             | 0.92             |
| B11-2                   | -                | 0.70             | 0.78             | 0.65             | -                | 0.71             | -                |
| B11-3                   | -                | 0.40             | 0.55             | 0.65             | 0.2              | 0.68             | 0.50             |
| B11-4                   | -                | -                | 0.07             | 0.07             | -                | 0.09             | -                |
| B12-1                   | -                | 0.56             | 0.65             | 0.57             | -                | 0.38             | -                |
| B12-2                   | -                | 0.65             | -                | 0.59             | -                | -                | -                |
| B12-3                   | -                | 0.68             | -                | 0.72             | 0.6              | 0.87             | 0.82             |
| B12-4                   | -                | 0.80             | 0.97             | 0.80             | -                | 0.94             | 1.02             |
| B12-5                   | -                | 0.63             | -                | 0.58             | -                | 0.75             | -                |

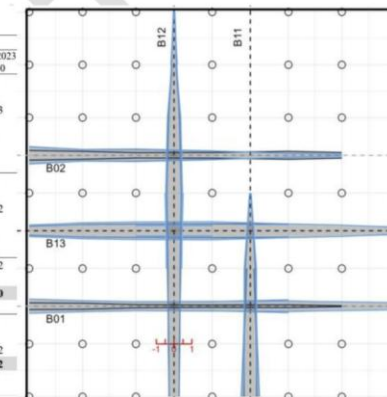


Fig. 17. Slab bottom cracks

# PrīmX Tehnoloģija

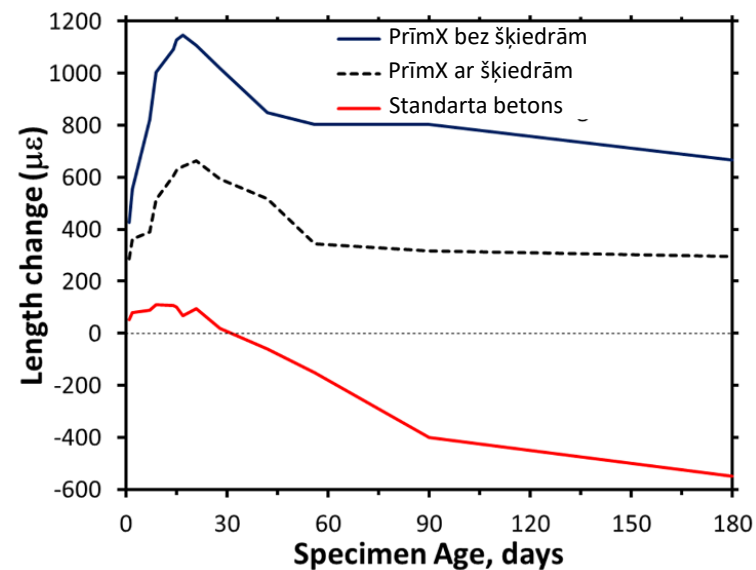
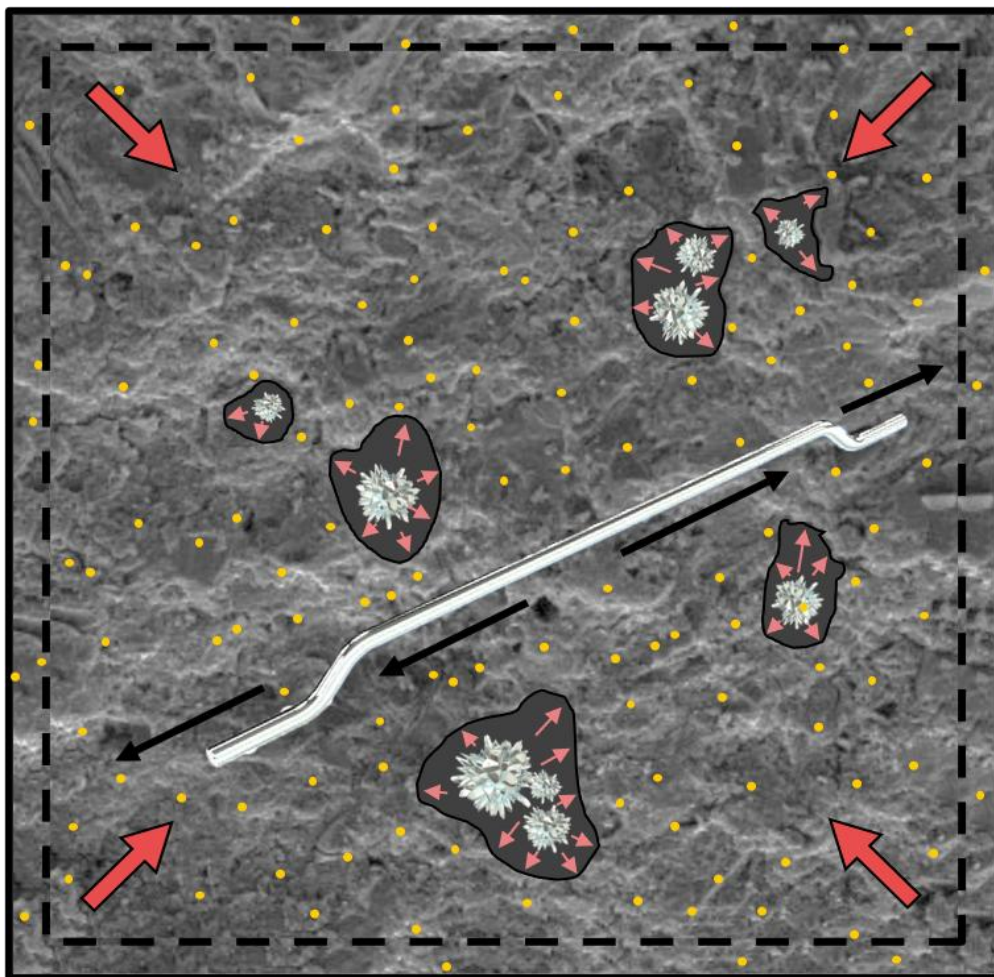
- 1 Tērauda šķiedru dispersi armēts, pašspriegojošs betons (SFRSSC)
- 2 Betona izplešanās rezultātā šķiedras tiek pakļautas stiepei, bet betons – spiedei
- 3 Tiek novērstas rukuma negatīvās sekas, un tiek panākts ķīmisks pašspriegojums
- 4 Rezultātā tiek iegūta stingāka konstrukcija

*Wet-curing process*



- Bezrukuma betons
- Mūžīgi līdzenas plātnes
- Palielināta nestspēja
- Kvizī-stinga plātne
- Samazinātas CO<sub>2</sub> emisijas

# PrīmX<sup>®</sup> pašspriegojošs betons (SFRSSC)



-  PrīmX DC izplešanās spēks
-  PrīmX betona matricas pretestība (pašspriegojuma spēks)
-  Tērauda šķiedru saspiegošanas (pretreakcijas) spēks
-  PrīmX betona matricas poru telpa
-  Ettringīts un citi PrīmX DC reakcijas produkti
-  Sākotnējais PrīmX tilpuma stāvoklis (0 dienas)
-  Izplesta tilpuma vienība PrīmX SFRSSC (14 dienas)
-  PrīmX CPEA



# PrīmX<sup>®</sup> ūdensnecaurlaidība

- Betona paraugu testēšana (EN 12390-8)
- 500 kPa Ūdens spiediens (~51 m ūdens spiediens) 72 stundas.
- Aizpildītas poras – labāka ūdensnecaurlaidība
- Multifunkcionāla piedeva = mazāk CO<sub>2</sub>

Overview of concrete compositions investigated

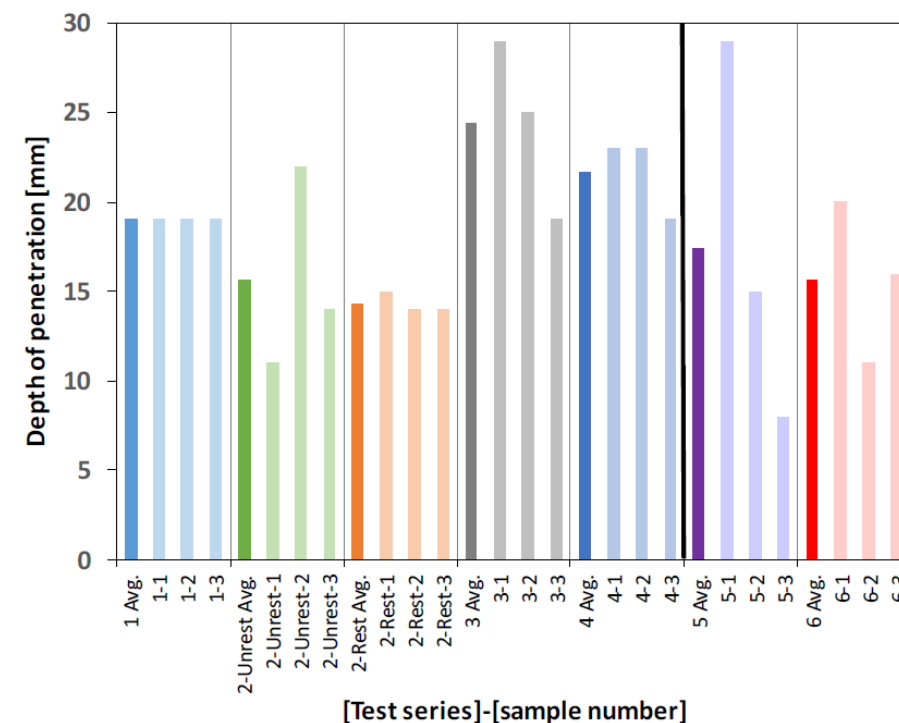
| Mixture ID | w/c ratio   | Steel fibre content, kg·m <sup>-3</sup> | Details on mineral additives |                             | Additional Notes          |
|------------|-------------|-----------------------------------------|------------------------------|-----------------------------|---------------------------|
|            |             |                                         | Type                         | Content, kg·m <sup>-3</sup> |                           |
| <b>1</b>   | <b>0.55</b> | <b>0</b>                                | <b>None</b>                  | <b>-</b>                    | <b>Reference concrete</b> |
| 2-Unrest   | 0.55        | 45                                      | PrīmX DC                     | 40                          | No external restraint     |
| 2-Rest     | 0.55        | 45                                      | PrīmX DC                     | 40                          | External restraint        |
| 3          | 0.55        | 0                                       | Type 1                       | 4                           | -                         |
| 4          | 0.55        | 0                                       | Type 2                       | 3                           | -                         |
| <b>5</b>   | <b>0.40</b> | <b>0</b>                                | <b>None</b>                  | <b>-</b>                    | <b>Reference concrete</b> |
| 6-Rest     | 0.40        | 45                                      | PrīmX DC                     | 40                          | External restraint        |

## ON THE APPLICATION OF STEEL FIBRE REINFORCED SELF-STRESSING CONCRETE (SFRSSC) IN WATERTIGHT CONCRETE STRUCTURES

Martins Suta<sup>1</sup>, Rolands Cepuritis<sup>2</sup>, S. Vaishnav Kumar<sup>3</sup>, Piyush Chaunsali<sup>3</sup>



(a)



(b)

Fig. 2. (a) Image of clear colour difference, used to measure the maximum water penetration depth and (b) the measured average (dark colour) and individual (pale colours) water penetration depths for the various Mixture IDs

**Bateriju Rūpnīca**

**PrīmX<sup>®</sup> Combideck**

**Pabeigta gigarūpnīca un tās risinājumi**

# Bateriju rūpnīca



**Būvniecības sākums:** feb. 2024

**Platība:** aptuveni 170 000 m<sup>2</sup>

**Pārsegumi:** 86 800 m<sup>2</sup>

**Grīda uz grunts:** 83 200 m<sup>2</sup>

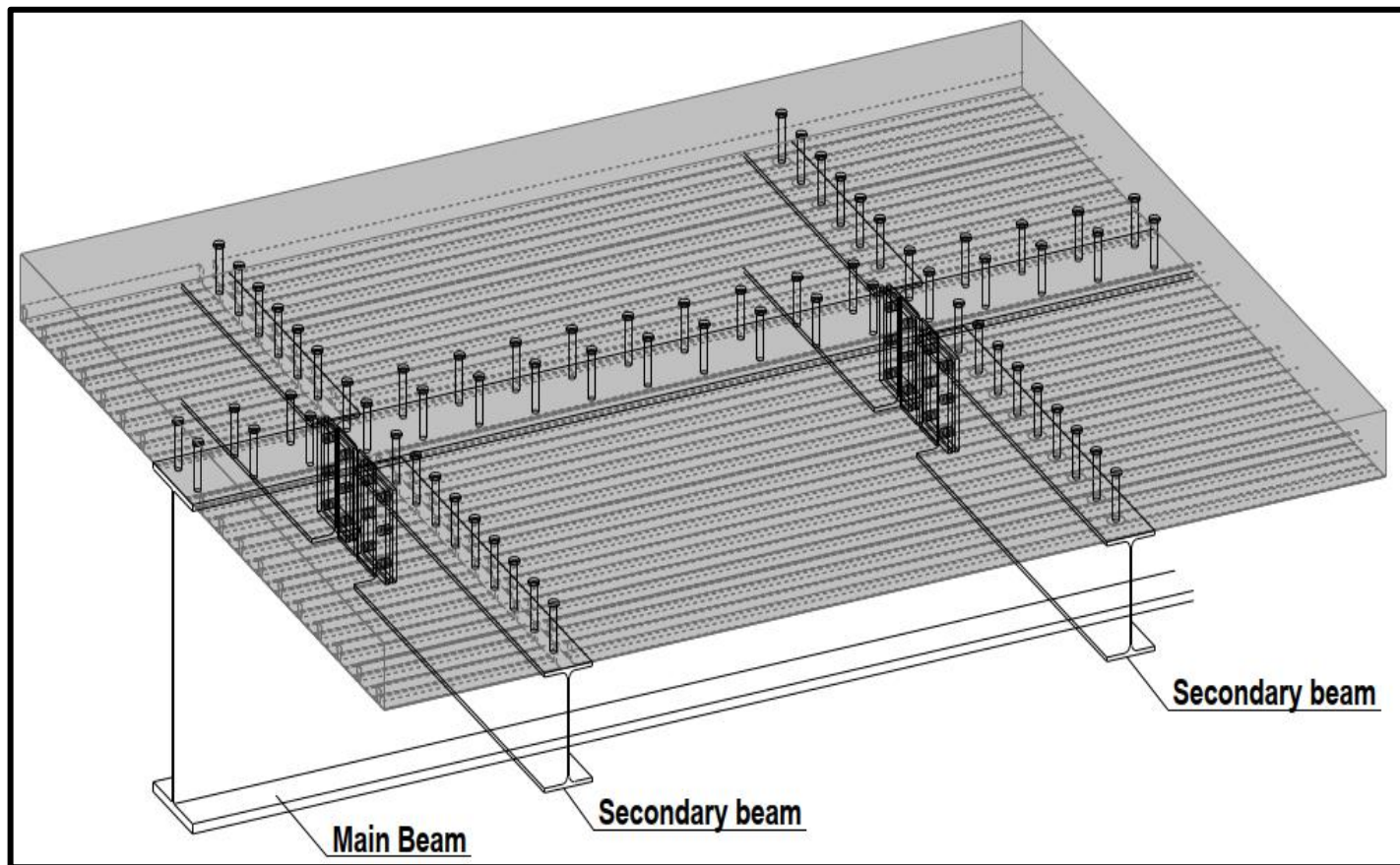
**Konstrukcijas:**

Metāla / Glulam karkass

Kompozītais pārsegums uz metāla sijām



# Ģeometrija / Slodzes



Isometry of typical area

- Kolonnu tīkls: 7,5 x 16m
- Sekundāro siju attālums: 2 m
- Kompozīt profils: SHR 51/150
- Betona biezums: 200 mm
- Lietderīgā slodze: 10.5 kN/m<sup>2</sup>
- Forkliftu slodze: (FL3)



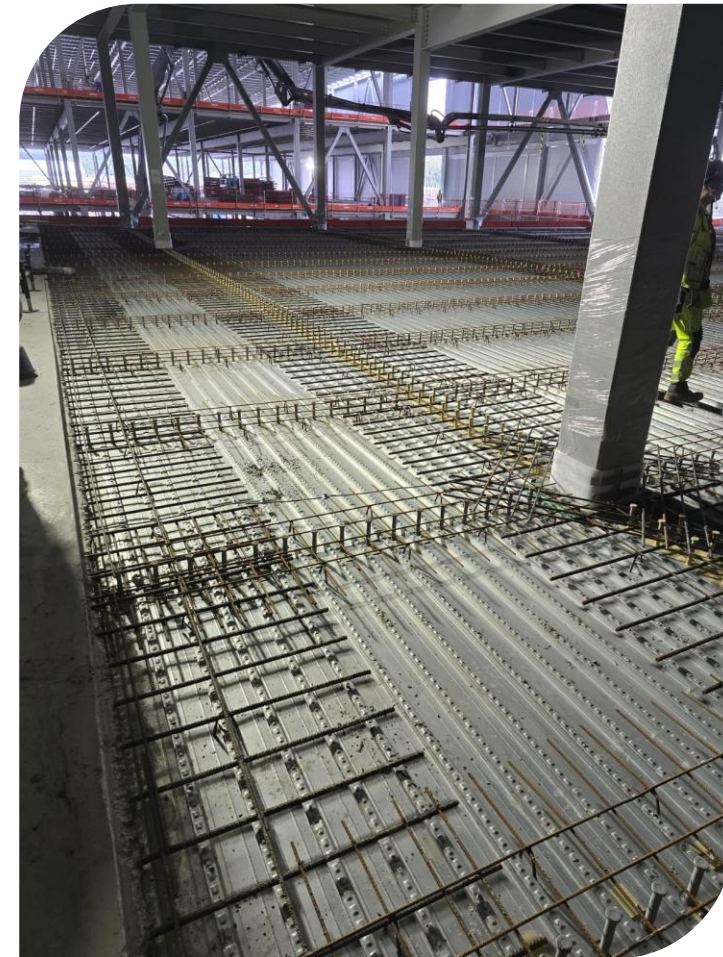
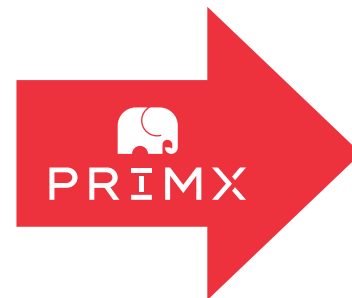
# Tipiskais stiegrojums standarta konstrukcijās:



- Lieces momenta stiegrojums
- Šķērsspēka stiegrojums
- Vērpes stiegrojums
- Caurspiešanas stiegrojums
- Tehnoloģiskais stiegrojums



# PrīmX<sup>®</sup> Optimizācija



## STIEGROJUMS

LIECES MOMENTS

ŠĶĒRSSPĒKS

PLAISU KONTROLE

AIZSTĀTS AR ŠĶIEDRĀM

GARENBĪDE STARP TĒRAUDA SIJĀM  
UN BETONA PLĀTNI

RISINĀJUMS VIENKĀRŠOTS /  
STIEGROJUMS

# PrīmX® Optimizācija

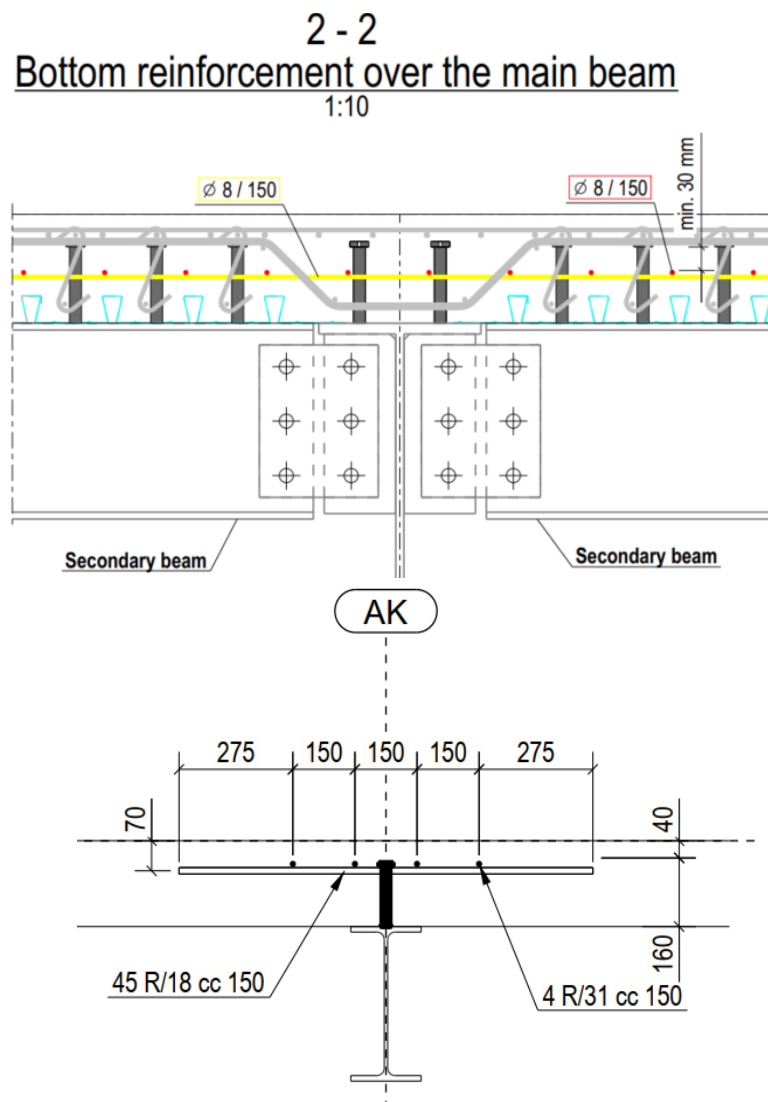
## Projekta risinājums

### Oriģinālais risinājums

- Biezums: 200mm
- Stiegrojums: 230kg/ m<sup>3</sup>
- Šķiedru dozācija: 0 kg/m<sup>3</sup>

### PrīmX® risinājums

- Biezums: 200mm
- Stiegrojums: 40kg/ m<sup>3</sup>
- Šķiedru dozācija: 30 kg/ m<sup>3</sup>



## Ieguvumi

- 160 metru gari pārsegumi bez deformācijas šuvēm
- 50% ietaupīts laiks izbūvē
- Vairāk nekā 3x mazāks CO<sub>2</sub> izmešu apjoms
- Risinājums pateicīgs nākotnes izmaiņām
- Deformācijas šuvju atvērumi salīdzinoši nelieli (2-4 mm)

## Ilgtermiņa ieguvumi

- Nākotnei gatava ēka piesaista vairāk nomnieku
- CO<sub>2</sub> ietaupījumu var izmantot ēkas CO<sub>2</sub> bilances kompensēšanai
- 10 gadu garantija
- Izmaksu ziņā efektīvs risinājums
- Combideck sistēmā viegli izgriezt atvērumus



# PrīmX® Optimizācija

| Pozīcija, vienības                              | Saskaņā ar oriģinālo risinājumu | Saskaņā ar PrīmX® risinājumu | Ietaupījums  |
|-------------------------------------------------|---------------------------------|------------------------------|--------------|
| Kopējā pārsegumu platība, m <sup>2</sup>        | 86 800                          | 86 800                       | N/A          |
| Nepieciešamais betona apjoms, m <sup>3</sup>    | 17 360                          | 17 360                       | N/A          |
| Kopējais nepieciešamais stiegrojums, ton        | 3 993                           | 1 215                        | <b>2 778</b> |
| Darba stundas armatūras ieklāšanai, c·d         | 9 982                           | 3 038                        | <b>6 944</b> |
| Kopējās iebūvētās CO <sub>2</sub> emisijas, ton | 8 784                           | 2 673                        | <b>6 111</b> |

- **70% ietaupījums** nepieciešamajā stiegrojumā!
- Vairāk nekā **6 000 tonnu** iebūvēto emisiju samazinājums **bez papildus izmaksām**
- Samazināts darba apjoms 41 darbiniekam **8 mēnešu** garumā.



PRIMX

# Labākā oglekļa emisiju samazināšanas stratēģija

PrīmX betona tehnoloģija jau šodien nodrošina 2050. gada mērķus



## Efektivitāte projektēšanā un būvniecībā

Vienkāršāki projektētie risinājumi – mazāk lieka darba  
Optimizēti risinājumi  
Inovatīva pieeja



## Efektivitāte projekta un budžeta skatījumā

Mazāk betona un tērauda = zemākas materiālu izmaksas  
Mazāk darbaspēka un ātrāka izbūve  
Katrs neielietais m<sup>3</sup> = tūlītējs CO<sub>2</sub> samazinājums

**= Mazāks materiālu patēriņš = Mazākas CO<sub>2</sub> emisijas**



# Efektivitāte betona konstrukcijās, kas veicina CO<sub>2</sub> emisiju samazināšanu



**Valters Sējāns**  
Projektēšanas Projektu Vadītājs  
Primekss



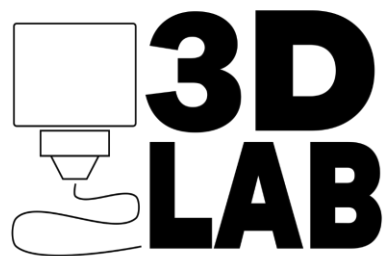


# Research at RTU focusing on reducing Environmental Footprint of Concrete

Riga Technical University

Faculty of Civil and Mechanical Engineering

Institute of Sustainable Building Materials and Engineering  
Systems



27.11.2025

Dr. Sc. Ing.

Maris Sinka

Dr. Sc. Ing.

Genadijs Sahmenko



**SWISS – LATVIAN**  
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Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra



Ministry of  
Education and Science  
Republic of Latvia



Latvian Council of Science



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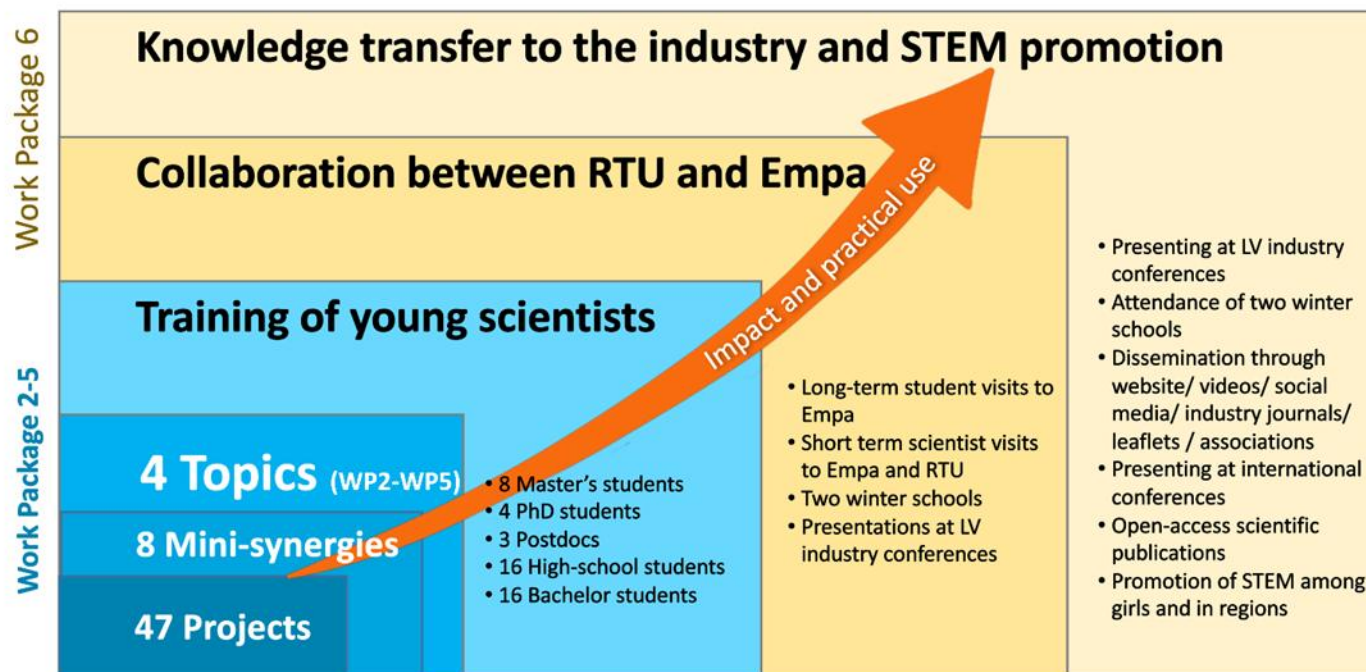


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Materials Science and Technology



## Framework: **project-based collaboration**





## Partners

RTU Faculty of Civil and Mechanical Engineering  
Faculty of Natural Sciences and Technologies  
Institute of Photonics, Electronics and Telecommunications

Scientific  
partners



Empa, Concrete and Asphalt Laboratory



Latvian State Roads  
Latvian Road Builders Association  
Latvian Concrete Association

Advisory board  
from industry



Schweizerische Eidgenossenschaft  
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## Project management team



Viktors Haritonovs  
*Project manager*



Inga Labsvira - Zelča  
*Administrative project manager*



Lāsma Vaivare  
*Project communications manager*



Zanda Plūmiņa  
*Project content manager*

## Executive board and key scientists



Viktors Haritonovs



Mārtiņš Zaumanis



Nikolajs Toropovs



Māris Šinka



Genādijs Šahmenko



Pietro Lura



Remo Merijs - Meri

## WP leaders



Viktors Haritonovs



Mārtiņš Zaumanis



Genādijs Šahmenko



Māris Šinka



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
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Republic of Latvia



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## Advisory board

**Date of establishment: 22.05.2025.**

- Jānis Barbars (LSR)
- Rolands Cepurītis (LCA)
- Monta Berga (LRB)
- Jānis Zāle (LCA)



**SWISS – LATVIAN**  
Cooperation Programme



2025. – 2029.



ON ADVANCED CIVIL ENGINEERING MATERIALS

# WP4: Ultra-High Performance Fiber Reinforced Concrete (UHPFRC) for application as shotcrete (sprayed concrete)

Andrejs Kavlaks, Rūta Anna Kinta, Genādijs Šahmenko,  
Nikolajs Toropovs, Pietro Lura



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## THE PROBLEM

- Road infrastructure objects in Latvia: poor technical condition, aging, corrosion
- Long and complicated repair
- Limited industry experience

## THE AIM

- To develop durable UHPFRC shotcrete solutions to repair and protect marine and road infrastructure exposed to harsh climates and corrosion
- To promote UHPFRC shotcrete in Latvia, using local resources



## ABOUT LACHMAT

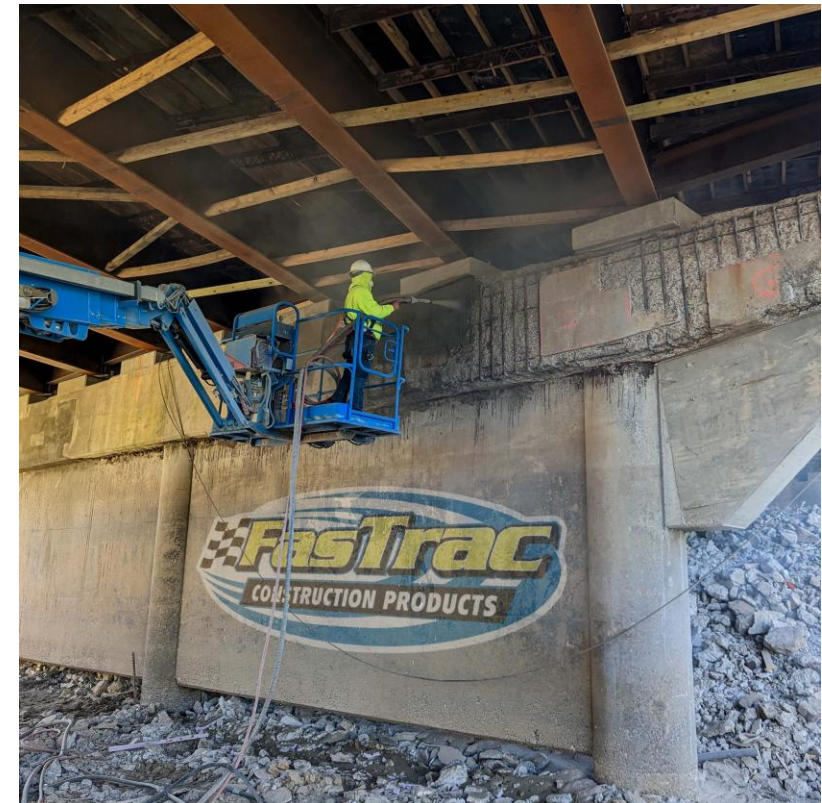
## UHPFRC

- Superior strength ( $> 120$  MPa)
- Durability ( $> 500$  cycles)
- Crack resistance
- Impermeability



## SHOTCRETE

- Fast application
- No formwork required
- Suitable for both new construction and repair



<https://www.fastracproducts.com/fastrac-structural-shotcrete/>

## UHPFRC AND SHOTCRETE

## MAIN ACTIVITIES

## POTENTIAL RESULTS



## ABOUT LACHMAT

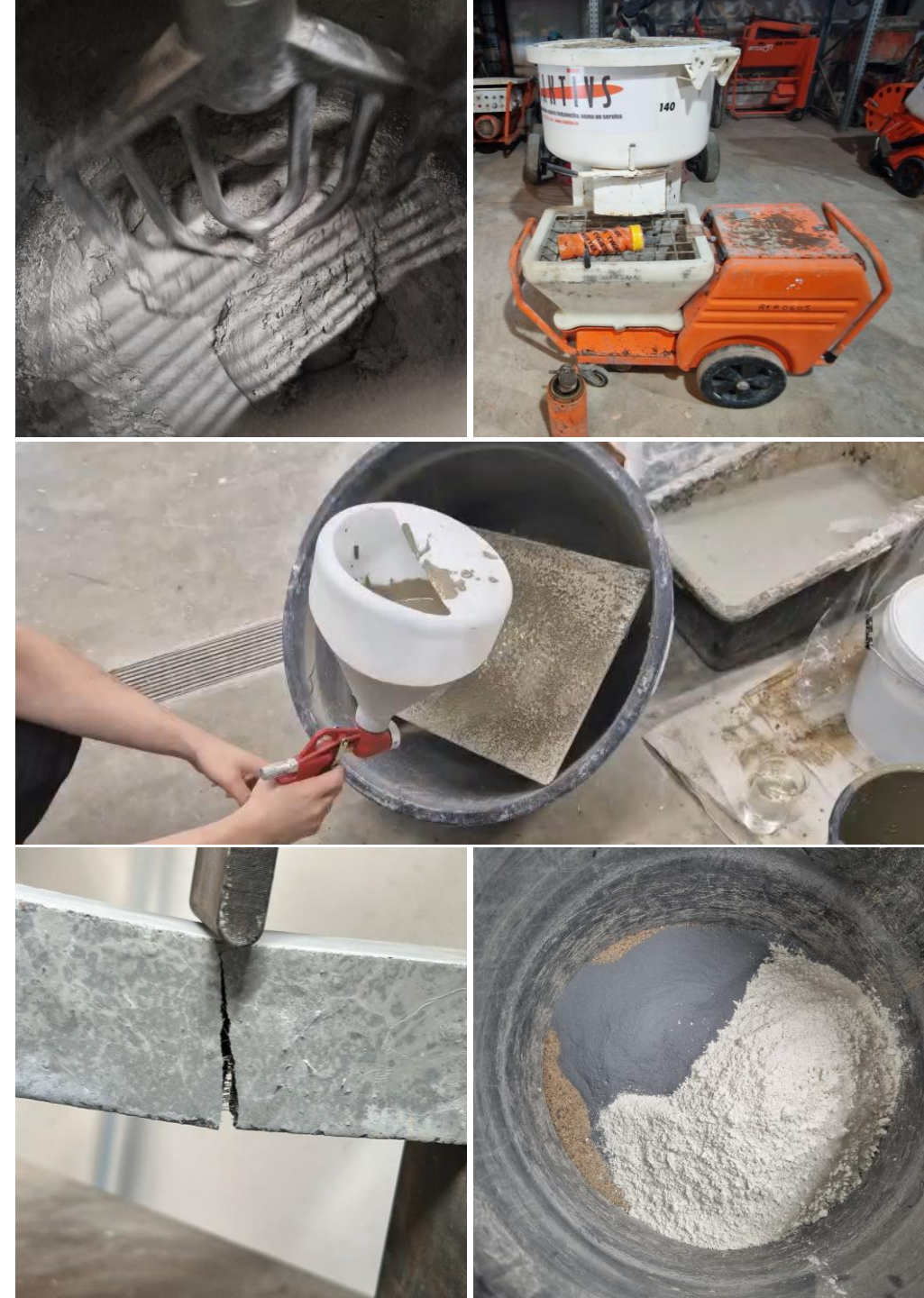
## PROJECT AIM, RELEVANCE

## UHPFRC AND SHOTCRETE

## MAIN ACTIVITIES

## POTENTIAL RESULTS

- Literature review on UHPFRC mix design
- Material preparation
- Laboratory testing and shotcrete prototyping
- Large-scale experiments
- Guidelines for industry applications



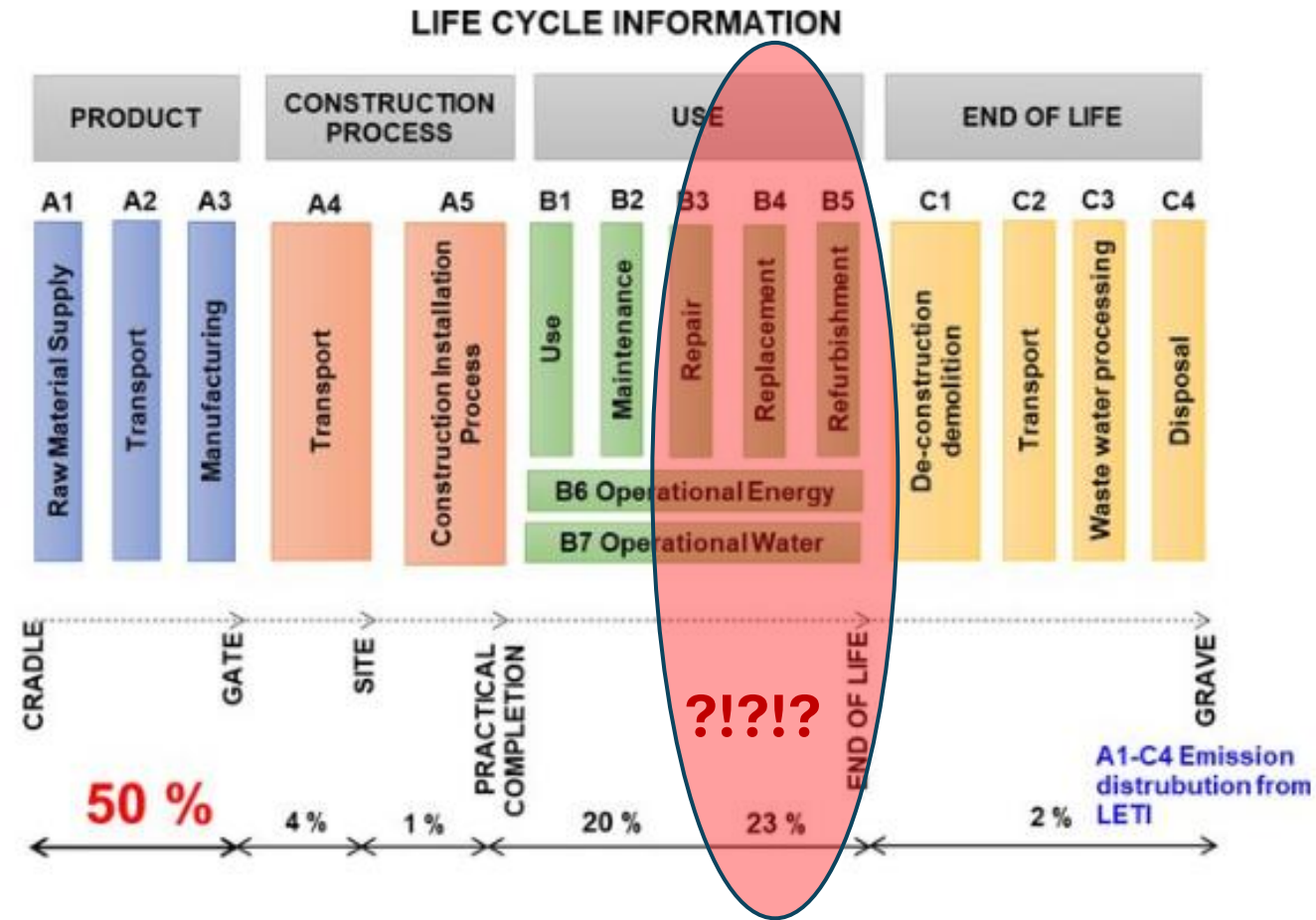
## ABOUT LACHMAT

## PROJECT AIM, RELEVANCE

## UHPFRC AND SHOTCRETE

## MAIN ACTIVITIES

## Sustainable solutions



- Both protective and strengthening properties
- Thinner protective layer
- More durability and more service life
- **LOWER ENVIRONMENTAL IMPACT !!!**

**SWISS – LATVIAN**  
Cooperation Programme



2025. – 2029.



ON ADVANCED CIVIL ENGINEERING MATERIALS



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UNIVERSITY



**Empa**

Materials Science and Technology

# WP5: Long-term Performance and Durability of 3D-Printed Concrete with Local Materials

Dāvis Dragons, Māris Šinka, Nikolajs Toropovs, Pietro Lura,  
Ellina Bernard

## THE PROBLEM

- Sustainability for 3D-Printed cementitious materials
- High CO<sub>2</sub> emissions in construction field

## THE AIM

- Investigation of sustainable and durable 3D-Printed cementitious materials
- Study on the use of bio-based aggregates
- Research and optimization of locally available materials
- Reduction of CO<sub>2</sub> emissions
- Potential collaboration with local manufacturers and industry
- Prototyping of different printable mixtures and construction elements



**ABOUT  
LACHMAT**

**PROJECT AIM,  
RELEVANCE**

**LOW  
CARBON  
CONCRETE**

**3D-  
PRINTABLE  
CLAY**

**WP4 & WP5  
TEAM**

## LOW CARBON CONCRETE

- Research of different mixtures without cement
- Analysis of the impact of hemp shives
- Potential use of 3D-Printed permanent mold
- Potential applications of landscaping objects



## 3D-PRINTABLE CLAY

- Potential industrial applications for replacing standard molds with reusable bio-based materials
- Potential collaboration with local clay manufacturers

3D-Printed clay  
reusable mold



Plywood molds  
currently used



ABOUT  
LACHMAT

PROJECT AIM,  
RELEVANCE

LOW CARBON  
CONCRETE

3D-  
PRINTABLE  
CLAY

LACHMAT  
TEAM

## WP4 AND WP5 TEAM



**Rūta Anna Kinta**  
Master's student (WP4)



**Andrejs Kavlaks**  
PhD student (WP4)



**Dāvis Dragons**  
PhD student (WP5)



## CO<sub>2</sub> storage in recycled concrete waste

- The project focuses on storing CO<sub>2</sub> in recycled concrete construction waste using a special processing and controlled carbonization method.
- Up to 10% of the concrete waste mass can be stored, significantly reducing the CO<sub>2</sub> footprint of the final product, as well as improving its properties.
- The solution is primarily intended for concrete manufacturers to carbonize their internal concrete waste, reducing the carbon footprint of concrete products.
- Looking for producers interested in collaboration – testing your waste material to quantify

| Betona stiprības klase | References betona emisijas A1-A3, kg CO <sub>2</sub> e / m <sup>3</sup> | LR B*90% | LR B*80% | LR B*70% | LR B*60% | LR B*50% |
|------------------------|-------------------------------------------------------------------------|----------|----------|----------|----------|----------|
| C8/10                  | 200                                                                     | 180      | 160      | 140      | 120      | 100      |
| C12/15                 | 210                                                                     | 190      | 170      | 145      | 125      | 105      |
| C16/20                 | 225                                                                     | 205      | 180      | 160      | 135      | 115      |
| C20/25                 | 240                                                                     | 215      | 190      | 170      | 145      | 120      |
| C25/30                 | 255                                                                     | 230      | 205      | 180      | 155      | 130      |
| C30/37                 | 275                                                                     | 250      | 220      | 195      | 165      | 140      |
| C35/45                 | 300                                                                     | 270      | 240      | 210      | 180      | 150      |
| C40/50                 | 325                                                                     | 295      | 260      | 230      | 195      | 165      |
| C45/55                 | 350                                                                     | 315      | 280      | 245      | 210      | 175      |
| C50/60                 | 370                                                                     | 335      | 295      | 260      | 220      | 185      |



CO<sub>2</sub> footprint of concrete can be reduced

250 kg CO<sub>2</sub>/m<sup>3</sup> → 200 kg CO<sub>2</sub>/m<sup>3</sup>

Interested in testing your waste concrete?

[maris.sinka@rtu.lv](mailto:maris.sinka@rtu.lv)



## Development and characterization of sustainable gypsum-cement-pozzolanic ternary compositions for 3D printing

The project aims to develop sustainable GCP compositions for 3D printing and promote the use of industrial by-products

More than 150 GCP compositions were developed.

GCP ternary mix = Gypsum (> 50%) + PC (< 25%) + MK

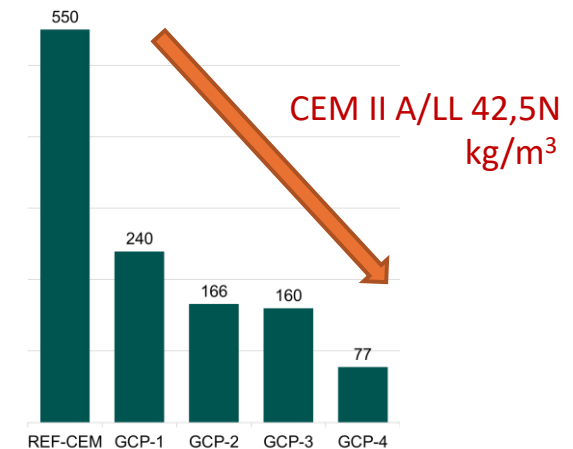
- recycled gypsum

- phosphogypsum

- oil shale ash

### FRESH MIX:

- Fast setting - GCP mix buildability up to 70 printed rows (REF cement mortar – up to 40 rows)
- Low cement content (up to 70 kg/m<sup>3</sup>)
- Recycling non-popular industrial waste



# PROPERTIES AND PRACTICAL USE OF 3DP GCP COMPOSITIONS

## Properties:

Compressive strength:

15 MPa (self-supporting)

40 MPa (load-bearing structural elements).

## Durability for outdoor use:

Water absorption < 15%;

Softening coefficient > 0.75;

Frost resistance confirms to XF1.

## Practical use in civil engineering:

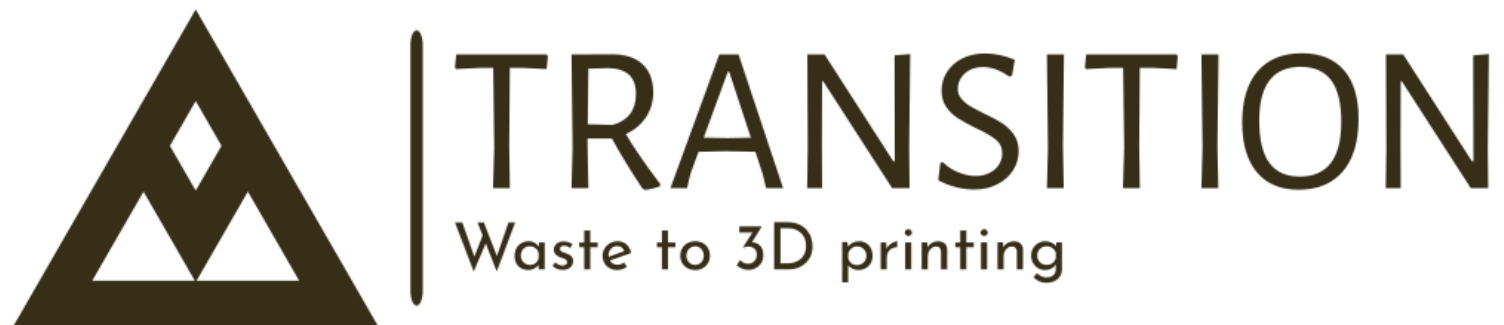
- specific architectural design elements of permanent formwork;
- acoustic panels for sound dispersion for indoor and outdoor use;
- environmental design objects, such as benches, flower boxes.
- facade panels and wall blocks



The environmental benefit of GCP mixes includes:

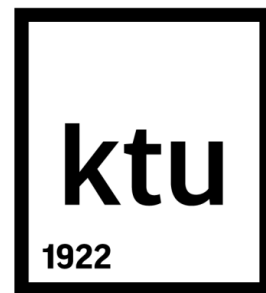
- reduced Portland cement content in binder up to 7 times
- twice less the CO<sub>2</sub> emissions compared to cement-based mixes





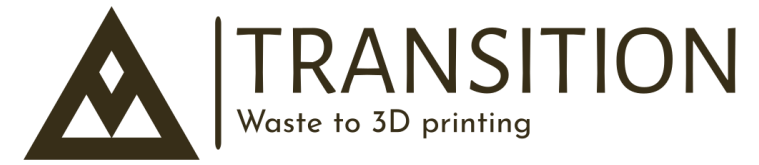
## Transforming Waste Into High-Performance 3D Printable Cementitious Composite

2023 SEPTEMBER – 2026 AUGUST  
<https://transition.rtu.lv/>





# Transforming Waste Into High-Performance 3D Printable Cementitious Composite



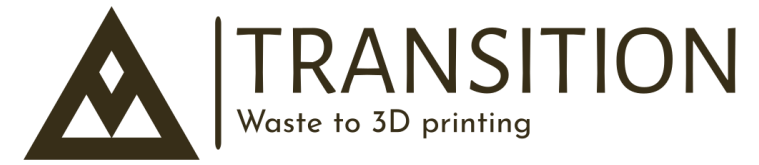
## Use of Oil Shale Ash in 3D Printable Concrete, Replacing Cement:

- Large amounts of waste in Estonia
- Can be used in cement production and concrete, have been done previously, have separate standard
- Various kinds available with new types of furnaces





# Transforming Waste Into High-Performance 3D Printable Cementitious Composite



## Use of Oil Shale Ash in 3D Printable

### Concrete, Replacing Cement:

- During the project, mixes using oil shale ash were developed.
- 40% of the cement was replaced, not lowering the properties
- CO<sub>2</sub> reduction of ~30%
- Large-scale prototype – LabLab2 just finished – 2.40m high sculpture.





# Low – CO<sub>2</sub> Concrete Printing Using Waste Materials



0% cement

+



Waste Ash with  
High CaO

+



Pozzolanic  
additives

+



Construction debris  
as aggregate

=

Low CO<sub>2</sub>  
3D printed  
buildings

The goal of this project is to reduce CO<sub>2</sub> emissions by using recycled waste aggregates (RWA) and industrial waste ash as binders in 3D printable concrete





# Low – CO<sub>2</sub> Concrete Printing Using Waste Materials

- Binders used in this project are without cement, uses OSA + metakaolin, can reach up to 30 MPa.
- Initial use – lost formwork or low requirement structures, lower strength required, only around 5MPa
- Significantly reduced CO<sub>2</sub> footprint, 50-90%.





# Building a Greener Future: 3D Printing with Natural Fibre Composites

This research project aims to create and test natural fibre composite materials, such as hempcrete, for 3D printing in construction. The goal is to produce resource-efficient, free-form structures with a lower environmental footprint, specifically by reducing CO<sub>2</sub> emissions.

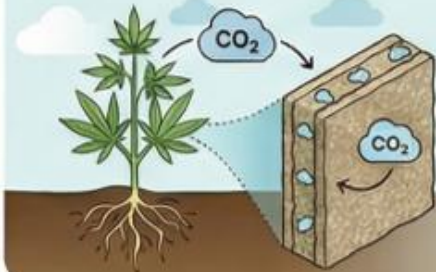
## The Sustainable Building Project

### Developing 3D-Printable Natural Fibre Composites

The project aims to create materials for both load-bearing and self-bearing structures.



### Hempcrete is a CO<sub>2</sub>-Sequestering Material



The use of bio-based materials like hempcrete can lead to **negative** CO<sub>2</sub> emissions.

### Evaluating Environmental Impact



Resource  
Extraction &  
Processing



3D Printing &  
Construction



End of Life

A Life Cycle  
Assessment is  
used to verify the  
sustainability of the  
new materials.



## Performance of 3D-Printed Hempcrete Walls

### Three Binder Materials Tested

The printed outer shell was tested with three different fast-setting binders.



Gypsum

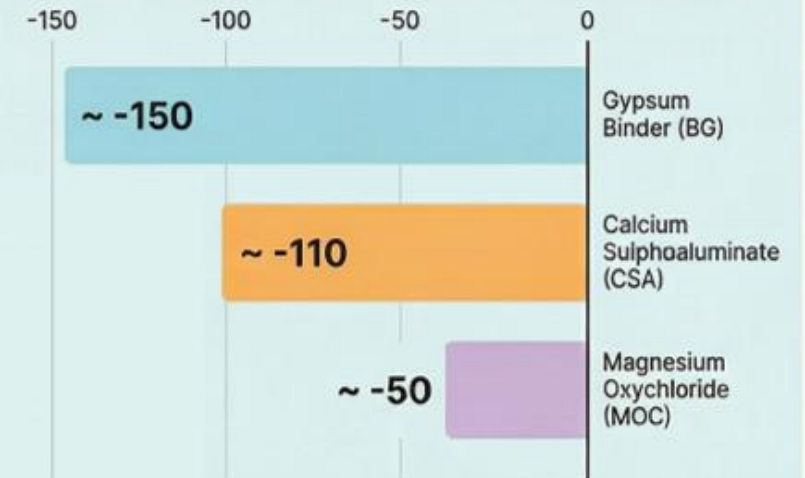


CSA



MOC

Absolute GWP (kg CO<sub>2</sub> eq.) - Lower (more negative) values are better



dr.sc.ing. Girts Frolovs  
Researcher

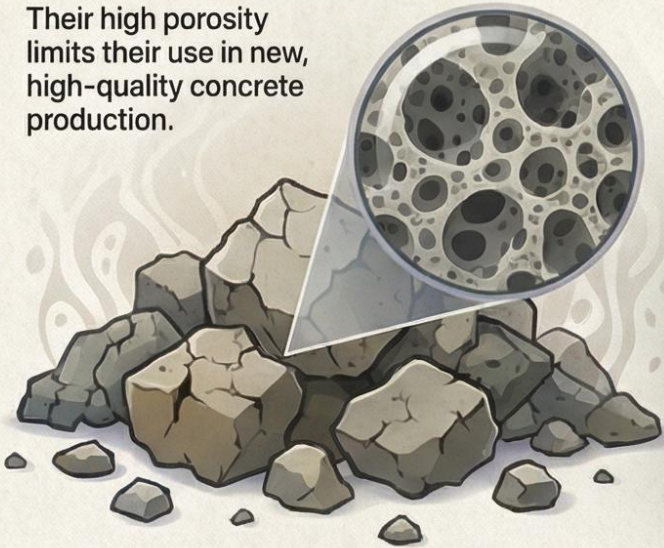
1.1.1.9 Research application No 1.1.1.9/LZP/1/24/085 of the Activity "Natural fibre composites with increased sustainability for 3D printed applications"



# Sustainable Concrete: How Microbes are Strengthening Construction

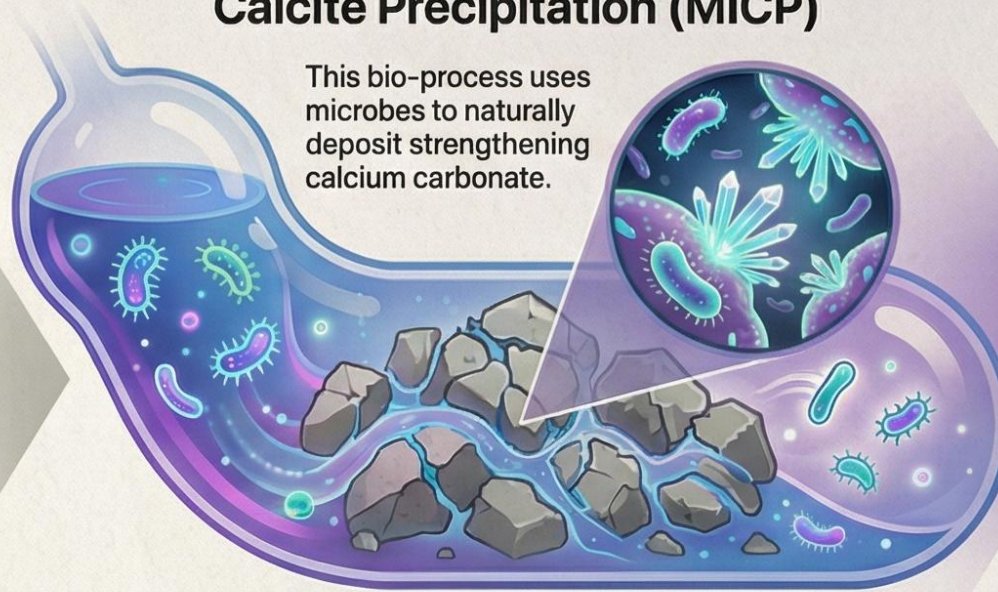
## Recycled Aggregates are Porous & Weak

Their high porosity limits their use in new, high-quality concrete production.



## Applying Microbial-Induced Calcite Precipitation (MICP)

This bio-process uses microbes to naturally deposit strengthening calcium carbonate.



## Stronger, Denser Aggregates

The deposited calcite fills pores, creating a superior and more durable base material.



**Mohmmmed H. Alzard**  
*PhD Engineering*

1.1.1.9 Research application No 1.1.1.9/LZP/1/24/086 of the Activity "Post-doctoral Research" "Utilization of Microbial-Induced Calcite Precipitation for Sustainable Concrete Production."



### High-Performance Sustainable Concrete

The treated aggregates yield concrete with enhanced mechanical and durability properties.



### Supports a Circular Economy

This method reduces CO<sub>2</sub> emissions and provides an alternative to natural aggregates.

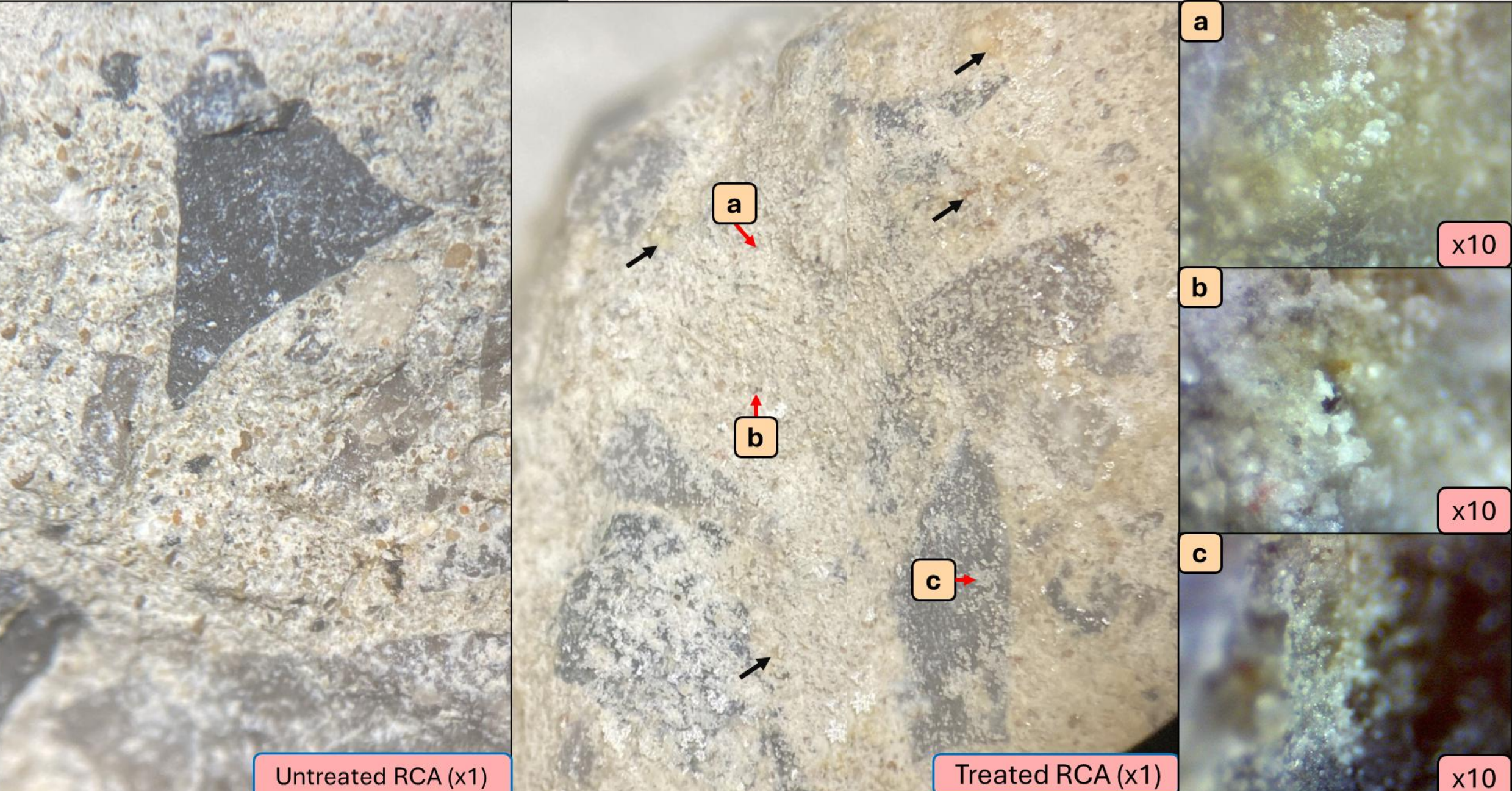


### Global Scientific Collaboration

International training in Ghent, Tokyo, and the US strengthens project outcomes.

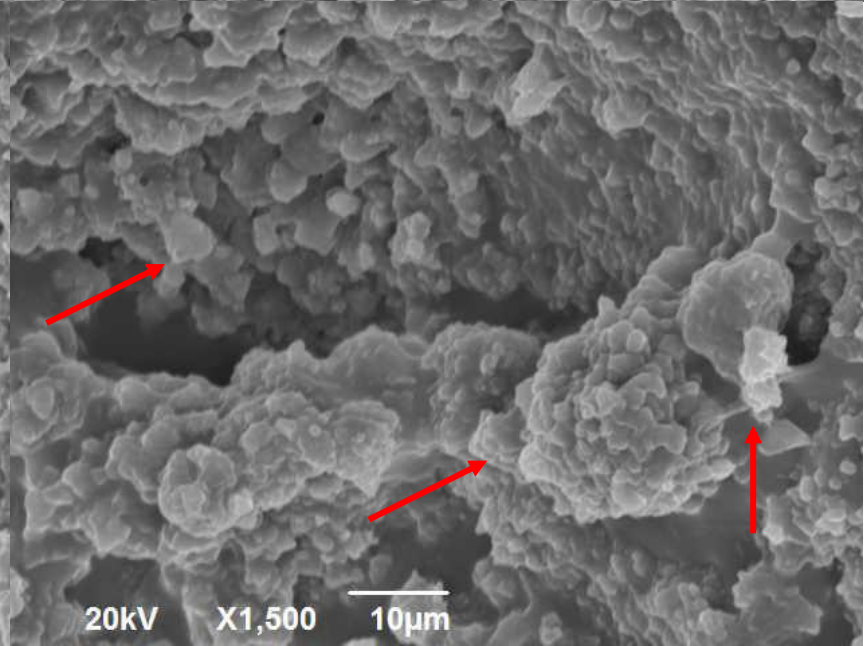
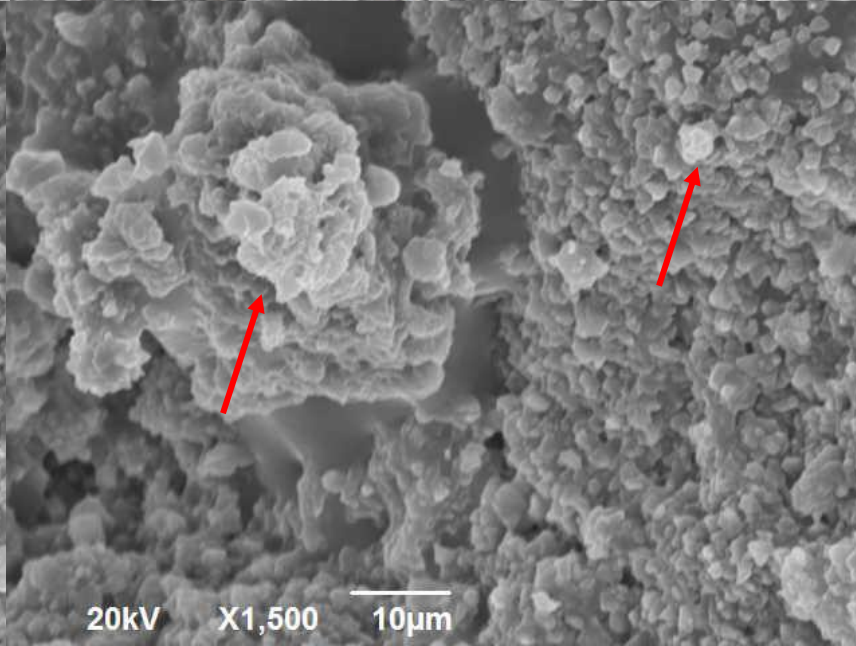
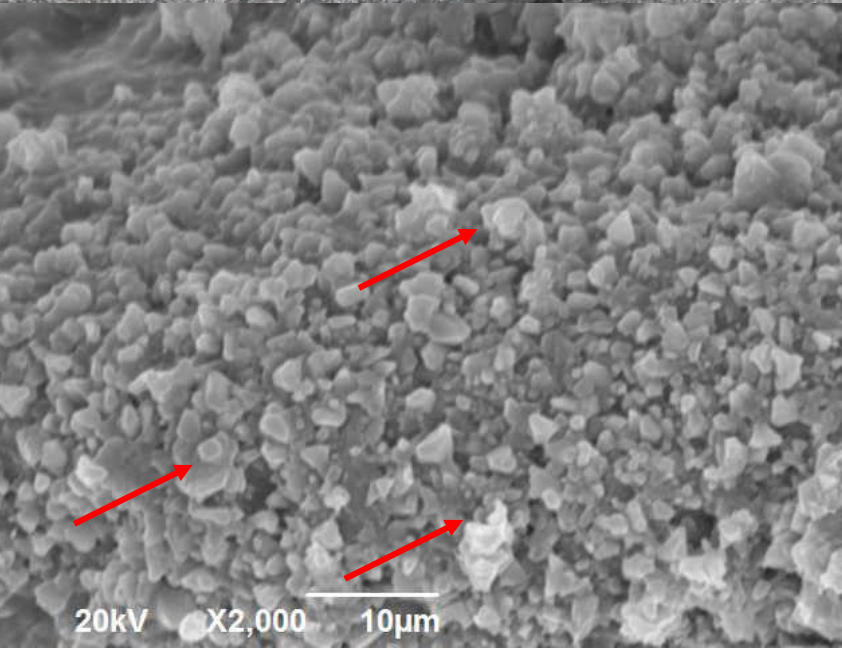
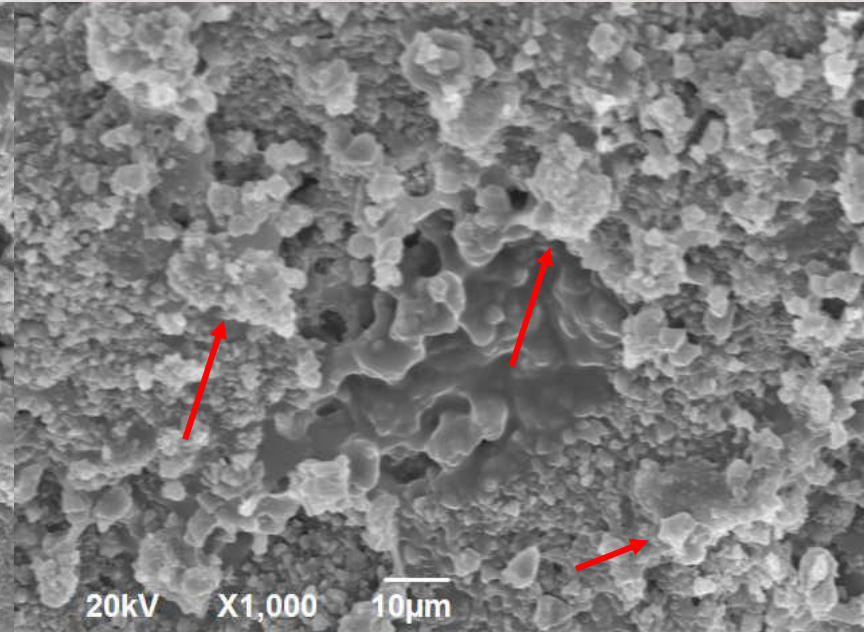
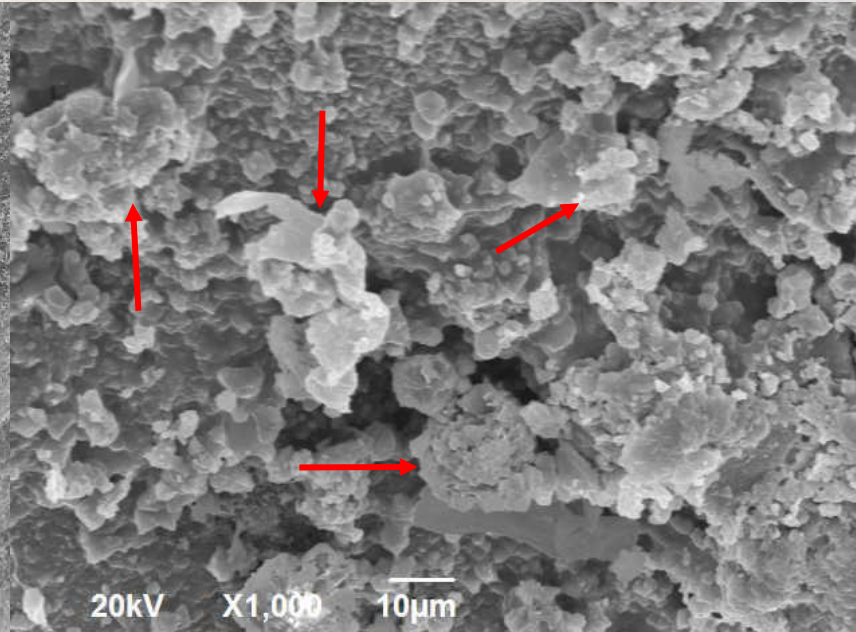
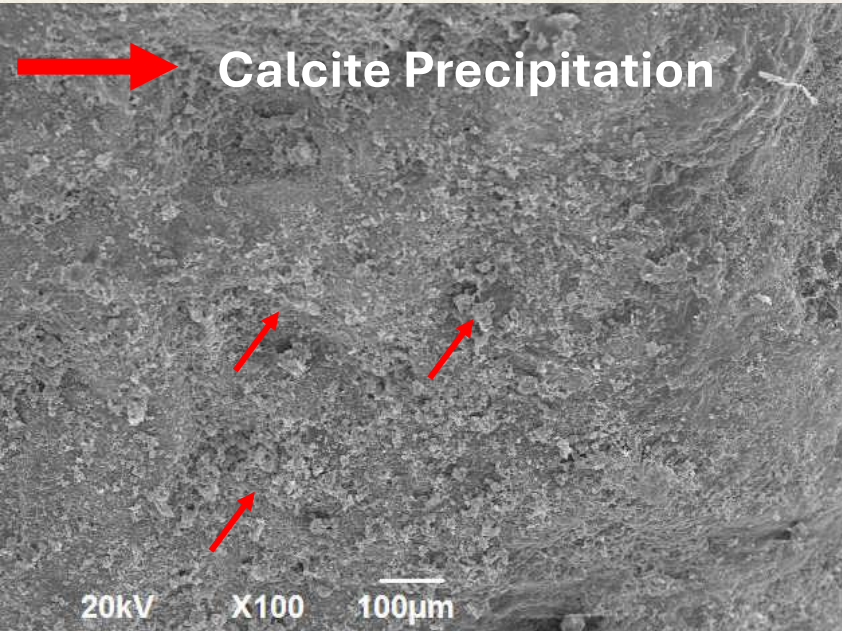


# Sustainable Concrete: How Microbes are Strengthening Construction





# Sustainable Concrete: How Microbes are Strengthening Construction





# Climate Impact of Construction Products and Services

- The aim of the project was to develop a basis for a national methodology for calculating the life cycle greenhouse gas (GHG) emissions of buildings.
- To create a database for main construction materials used in Latvia
- Integrated Latvian reference concrete from TK-04 guidelines

| Pētījuma komanda                                                                    |                                                              |                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Meža un koksnes produktu pētniecības un attīstības institūts | Projekta koordinators:<br>Laura Grabovska<br><br>Projekta tehniskais vadītājs:<br><b>Edvīns Grants</b><br><br>Pētnieks: <b>Māris Šinka</b>                                                         | <br>                                                                                        |
|  | Rīgas tehniskā universitāte                                  | Atbalsta: Tenūrprofesore Diāna Bajāre<br>Profesors Aleksandrs Korjaksins<br><br>Pētnieks: <b>Artūrs Riekstiņš</b><br><br>Atbalsta: Profesors Viktors Haritonovs<br><br><b>Marija Katrīna Dambe</b> | <br><br> |
|  | SIA «NOMAD Architects»                                       | Atbalsta:<br>Vidzemes Augstskola<br>Rīgas Enerģētikas Aģentūra                                                                                                                                     |                                                                                                                                                                                |
|  | Latvijas Biozinātņu un tehnoloģiju universitāte              | Pētnieks: Kaspars Grābens<br>Koordinē: <b>Anete Meija</b><br><br>Atbalsta: Aleksejs Nipers                                                                                                         | <br>                                                                                       |
|  | Latvijas Valsts mežzinātnes institūts "Silava"               | Pētnieks: <b>Andis Lazdiņš</b>                                                                                                                                                                     |                                                                                                                                                                              |

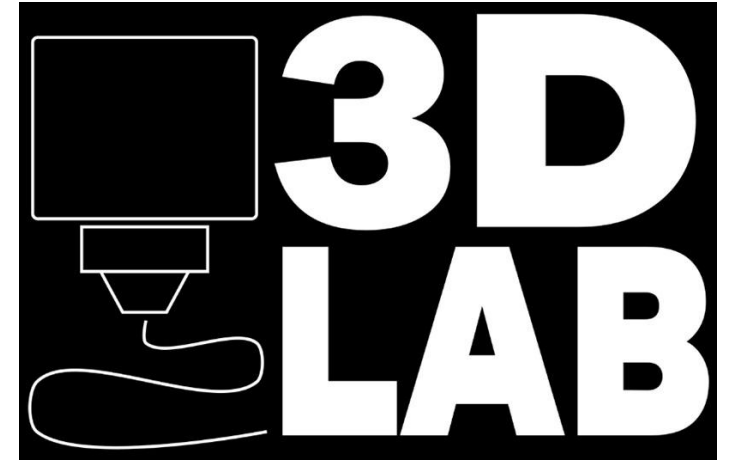
| Betona stiprības klase | References betona emisijas A1-A3, kg CO <sub>2</sub> e / m <sup>3</sup> | LR B*90% | LR B*80% | LR B*70% | LR B*60% | LR B*50% |
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| C40/50                 | 325                                                                     | 295      | 260      | 230      | 195      | 165      |
| C45/55                 | 350                                                                     | 315      | 280      | 245      | 210      | 175      |
| C50/60                 | 370                                                                     | 335      | 295      | 260      | 220      | 185      |

# Thank you!

## 3D Concrete Printing Lab

[maris.sinka@rtu.lv](mailto:maris.sinka@rtu.lv)

[3Dlab@rtu.lv](mailto:3Dlab@rtu.lv)



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[@Maris Sinka](#)

Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku būvkonstrukcijās. Pieredze projektēšanā un būvdarbos  
Choice to use cast-in-place concrete for structures of office centre Verde existing and new buildings. Experience during design and construction

Matīss Apsītis  
SIA ARENSO  
November 2025  
Slide number 1 of 23



# Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku būvkonstrukcijās. Pieredze projektēšanā un būvdarbos

## Choice to use cast-in-place concrete for structures of office centre Verde existing and new buildings. Experience during design and construction

Matīss Apsītis

SIA ARENSO

November 2025





Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku būvkonstrukcijās. Pieredze projektēšanā un būvdarbos  
Choice to use cast-in-place concrete for structures of office centre Verde existing and new buildings. Experience during design and construction

Matīss Apsītis  
SIA ARENSO  
November 2025  
Slide number 2 of 23



## Agenda

- Intro
- Verde + Cast-in-place concrete
- Structural design specifics
- Construction experience – Speed+Quality+Challenges

Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku būvkonstrukcijās. Pieredze projektēšanā un būvdarbos  
Choice to use cast-in-place concrete for structures of office centre Verde existing and new buildings. Experience during design and construction

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SIA ARENSO  
November 2025  
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AR  
EN  
SO



Team of  
structural  
engineers

AR  
EN  
SO



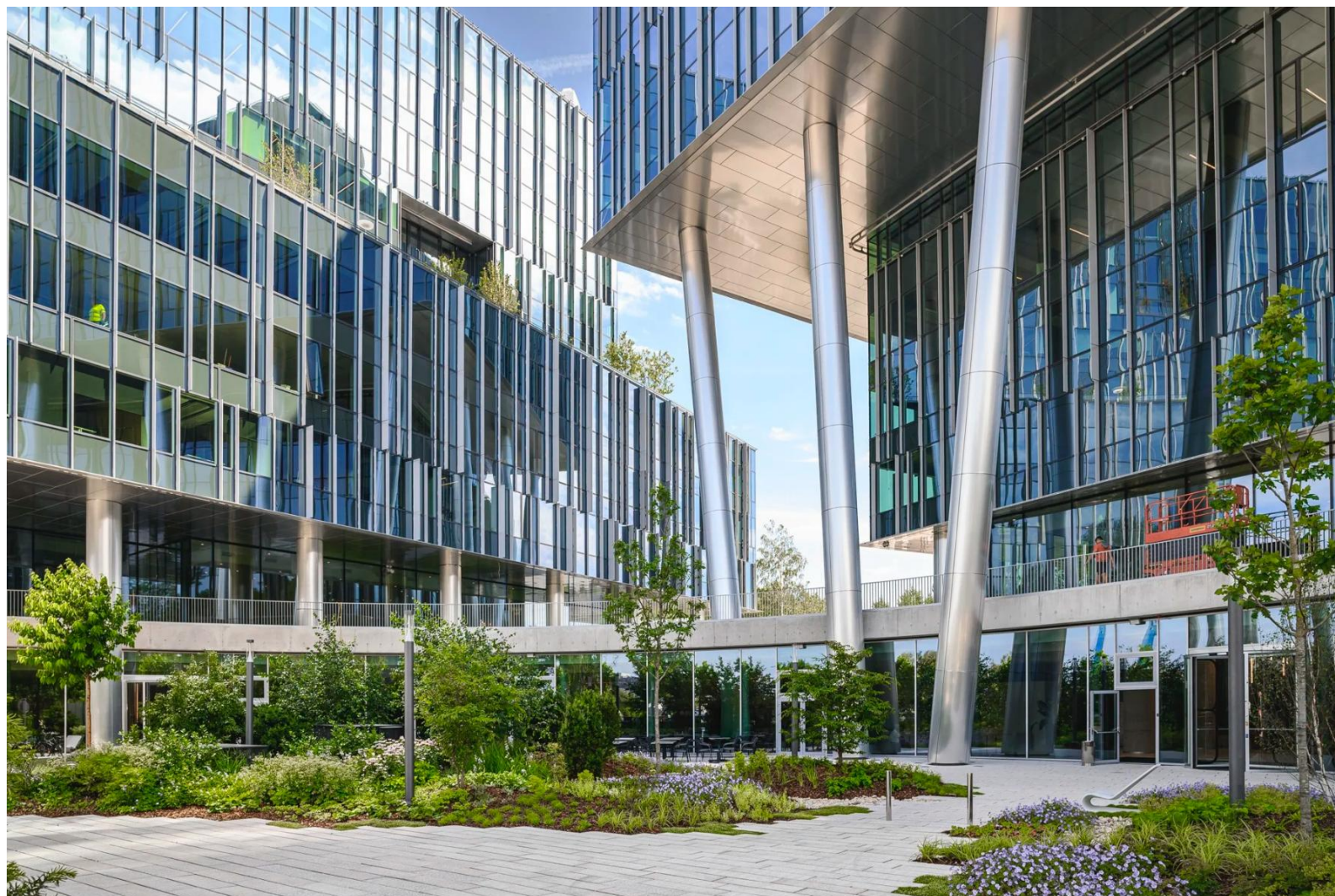
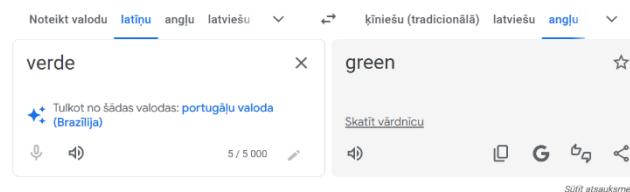


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# VERDE

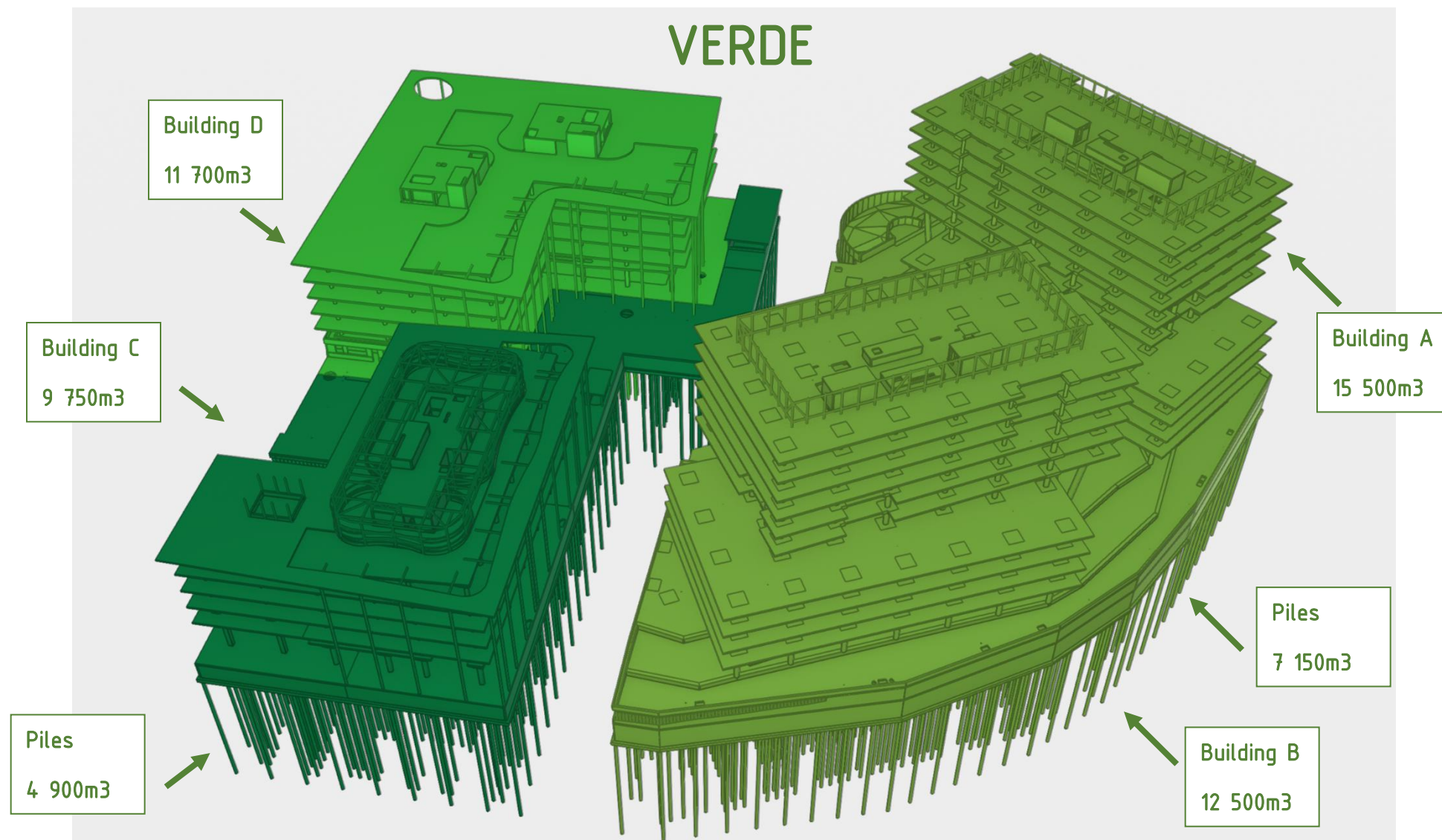




Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku  
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Total ~ 61 500m³ = ~21 000T CO<sub>2</sub> = ~0,3%LV<sub>per annum</sub>

**VERDE**  
KLŪST PAR ZALĀKO BIZNESĀ  
KVARTĀLU LATVIJĀ



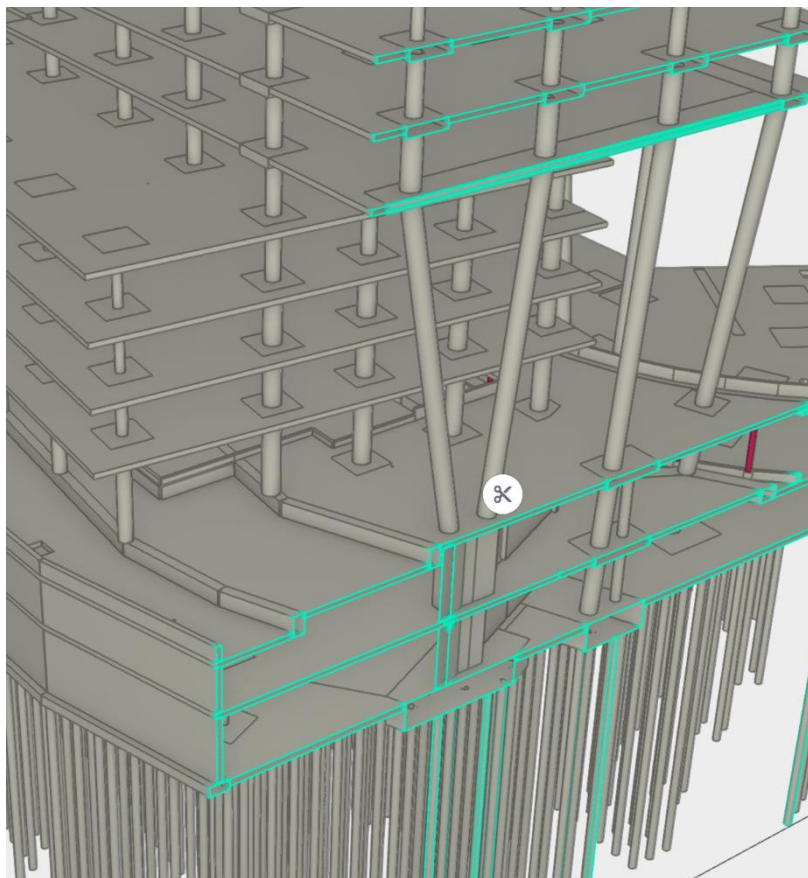
Latvijas  
Betona  
Savienība

Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku  
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SO

## Why Cast-in place?





Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku  
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## Why Cast-in place?





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## Why Cast-in place?





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## Verde CD



VERDE  
KLŪST PAR ZALĀKO BIZNESĀ  
KVARTĀLU LATVIJĀ

Latvijas  
Betona  
Savienība

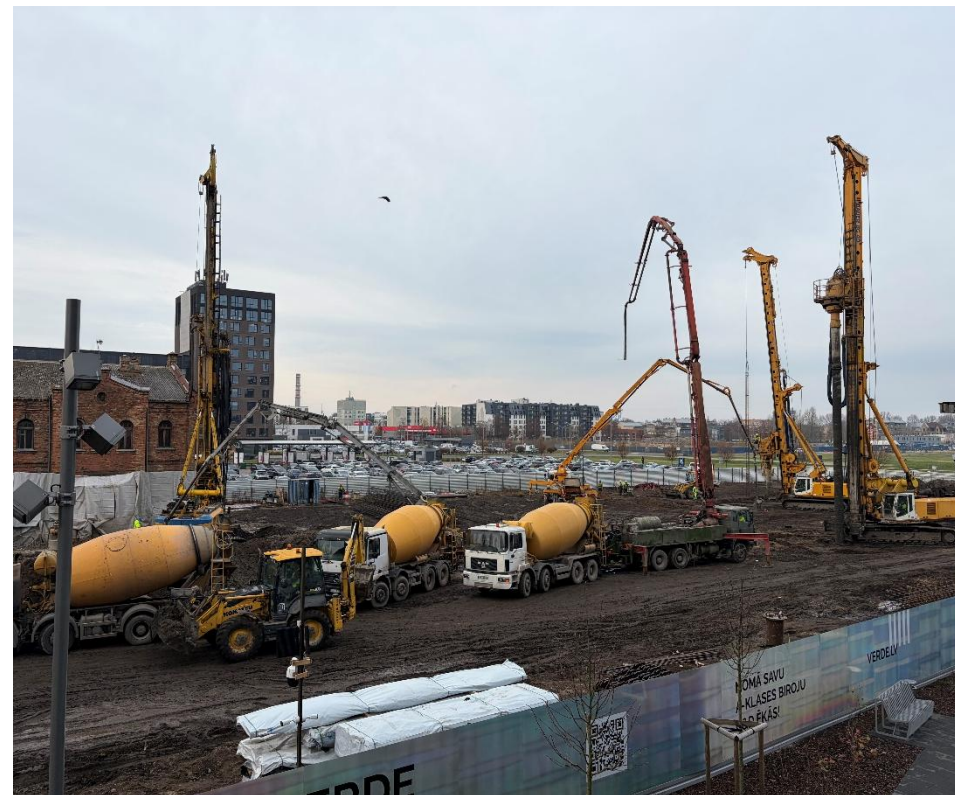
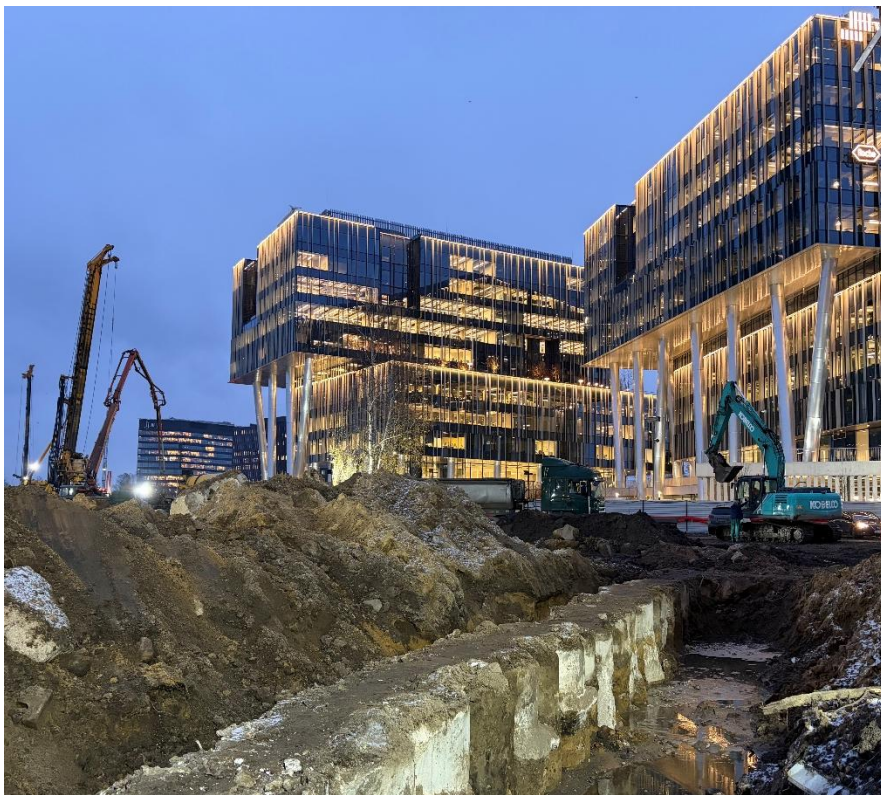


Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku būvkonstrukcijās. Pieredze projektēšanā un būvdarbos  
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## Design-Build without Design-Build



26.1 Būvprojekta izstrāde noslēdzas līdz ar būves nodošanu ekspluatācijā. Būvprojekta izstrāde ir šādas stadijas:

26.1.1. projekta koncepcija – stadija, kurā plānošanas risinājumu līmenī tiek izstrādāta un shematiski attēlota objekta novietne, plāni, telpiskie apjomi, kas dod priekšstatu par objekta veidolu un izvietojumu būvniecībai paredzētajā teritorijā (zemesgabalā);

26.1.2. ēkļu projekts – stadija, kad objekta projekts ir izstrādāts pakāpē, kas ļauj gūt plašu ieskatu par projekta plānojuma aspektiem, funkcionālo organizāciju, telpisko uzbūvi un izskatu, kā arī dod iespēju veikt stratēģisku izvēli starp funkcionālajām koncepcijām un paredzamajiem (plānotajiem) risinājumiem;

26.1.3. tehniskais projekts – stadija, kurā projekts ir izstrādāts tādā detalizācijas pakāpē, kas var nodrošināt būvdarbu izstrādi un izvēlēties būvdarbu veidojo, kā arī veikt būvinspekciju;

26.1.4. darba projekts – stadija, kurā projekts izstrādāts tādā tehniskās detalizācijas līmenī, kas nodrošina būvdarbu veikšanu un iekārtu izgatavošanu un to uzstādīšanu.

(MK 25.03.2025. noteikumu Nr. 196 redakcijā)

### Vispārīgie būvnoteikumi

Attēlotā  
redakcija

01.11.2025.... Spēkā esošā

VERDE  
KLŪST PAR ZALĀKO BIZNES  
KVARTĀLU LATVIJĀ



Latvijas  
Betona  
Savienība

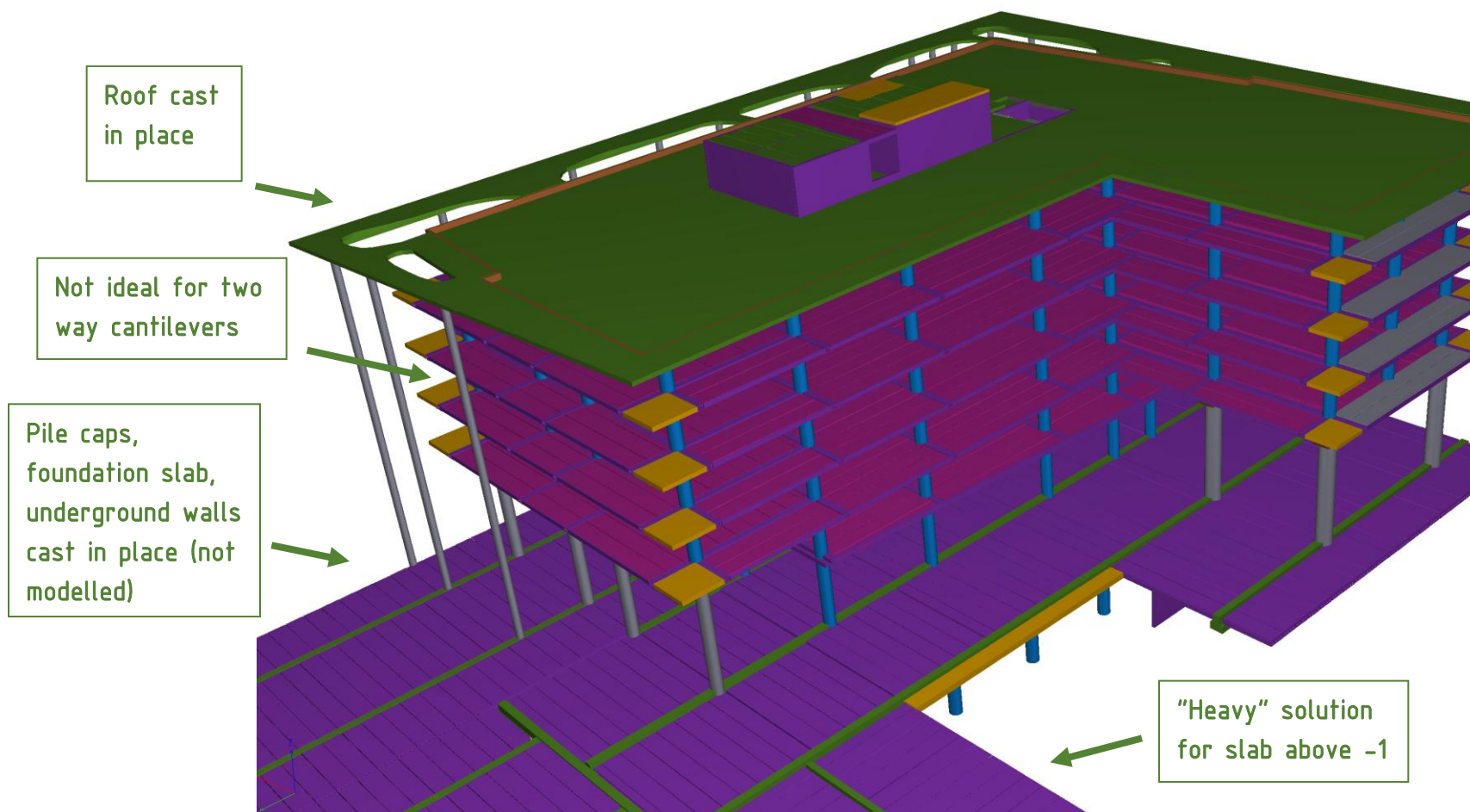


Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku  
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## Verde CD precast proposal

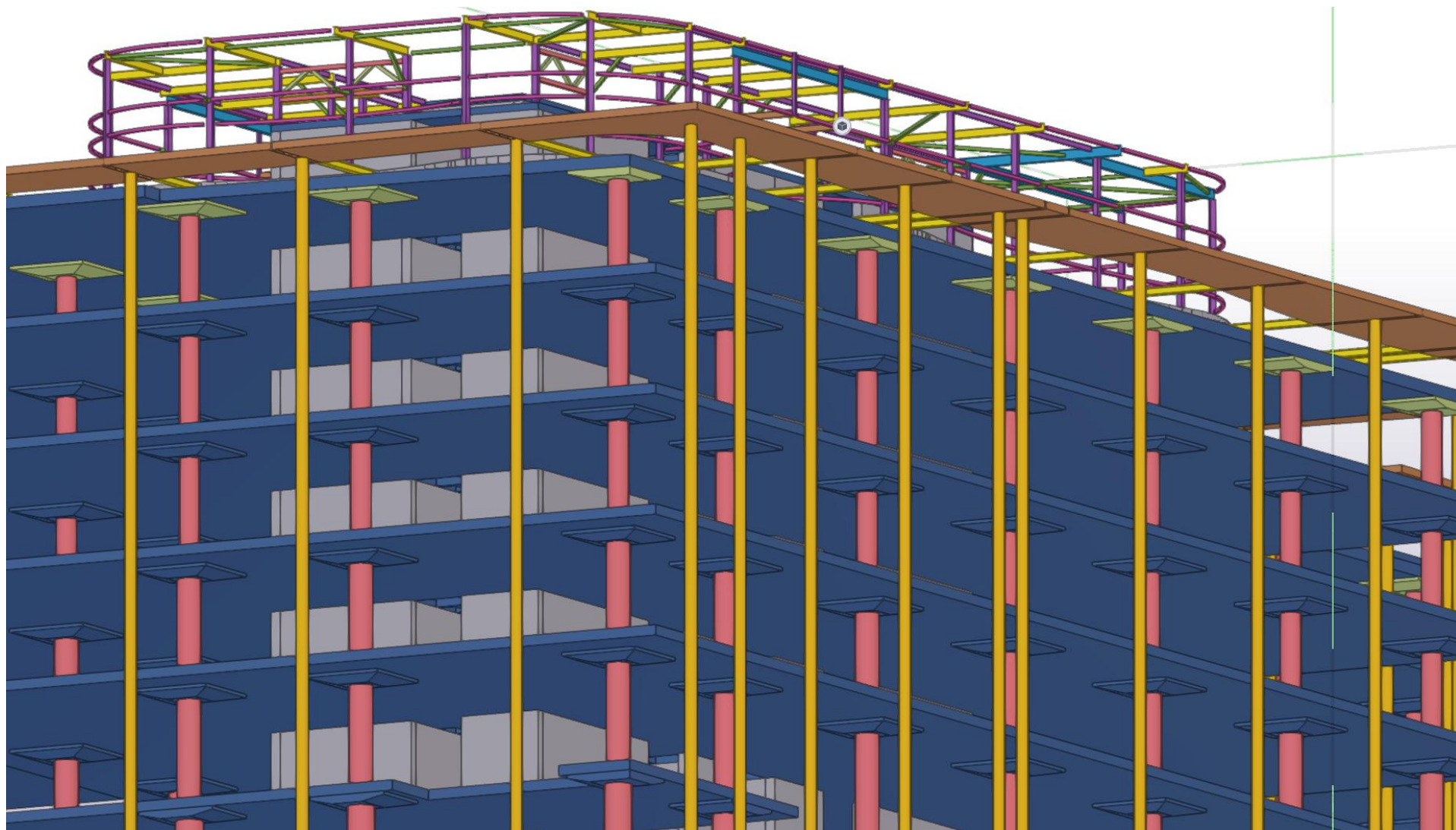


Izvēle lietot monolītu dzelzsbetonu biroja kompleksa Verde esošo un topošo ēku  
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## Verde CD cast-in-place proposal



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## Hard choice

- Precast cheaper at “typical” structures
  - Precast more expensive at long spans/high loads due to steel beam cost
  - Precast not possible for foundation, underground external walls
  - Precast not suitable for strange roof structures
  - Precast lighter – cheaper vertical structures (insignificant) and foundations (significant)
  - Precast aesthetically not very nice during construction and for exposure in offices
- 
- Good experience with cast-in-place construction companies
  - Cast-in-place more elastic for non-typical structural applications
  - No need to mix work/teams during construction
  - Insignificant gain in construction time
  - Cast-in-place more elastic for reconstruction – changes in layouts of offices, additional openings for stairs/MEP solutions.



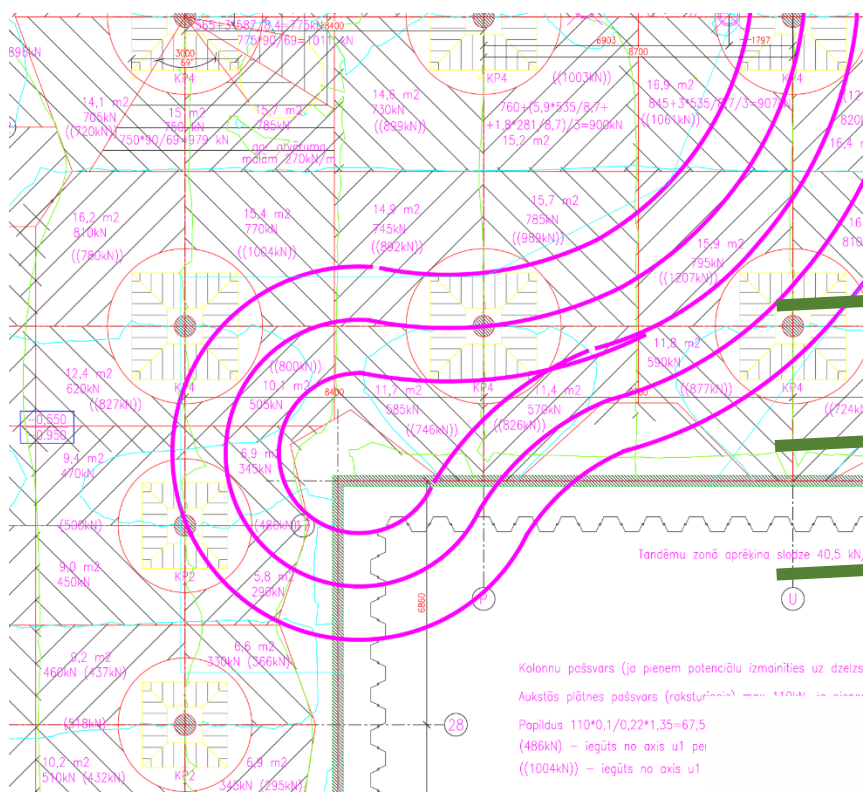
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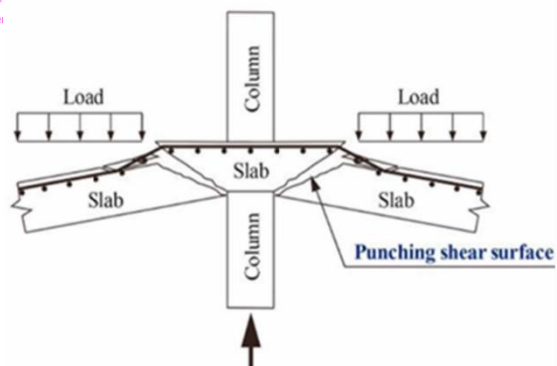
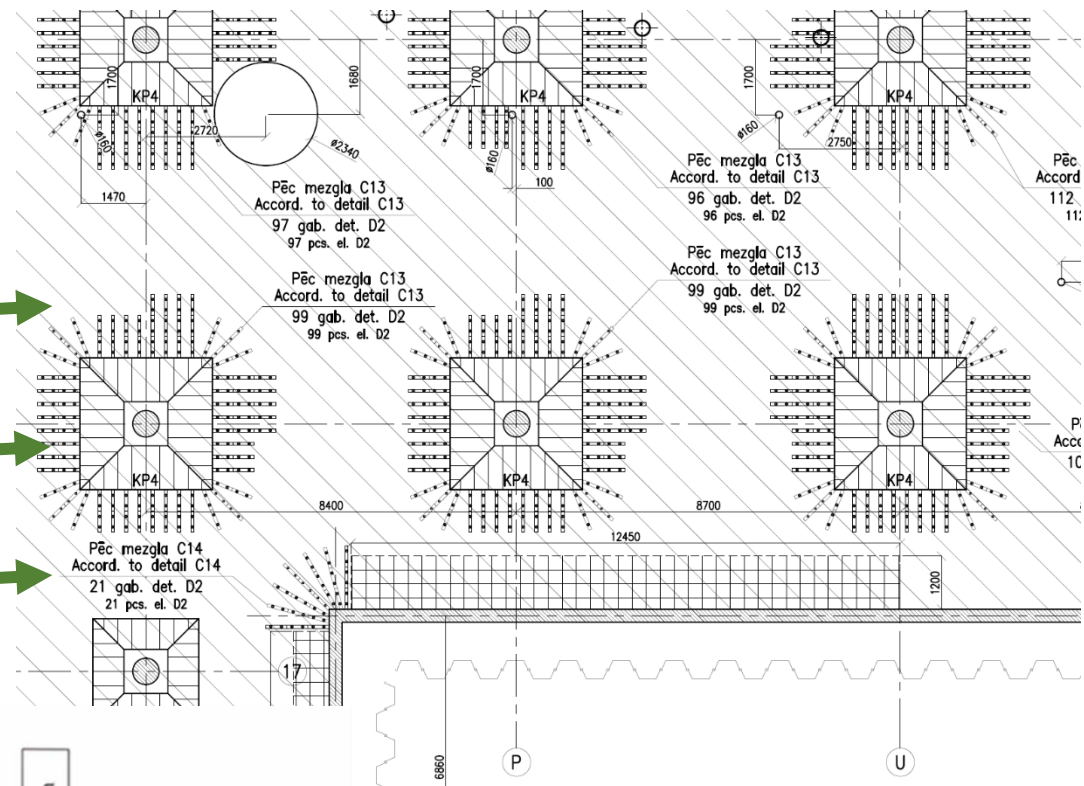
AR  
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## Design challenges

- Punching shear



Kolonnu pašsvārs (ja piemēram potenciālu izmaiņās uz dzelzi)  
 Aukstās plātnes pašsvārs (rokstūrīnā)  $\approx 110kN$  ja plātnes  
 Papildus  $110 \cdot 0,1/0,22 \cdot 1,35 = 67,5$   
 (486kN) – iegūts no axis u1 per  
 ((1004kN)) – iegūts no axis u1



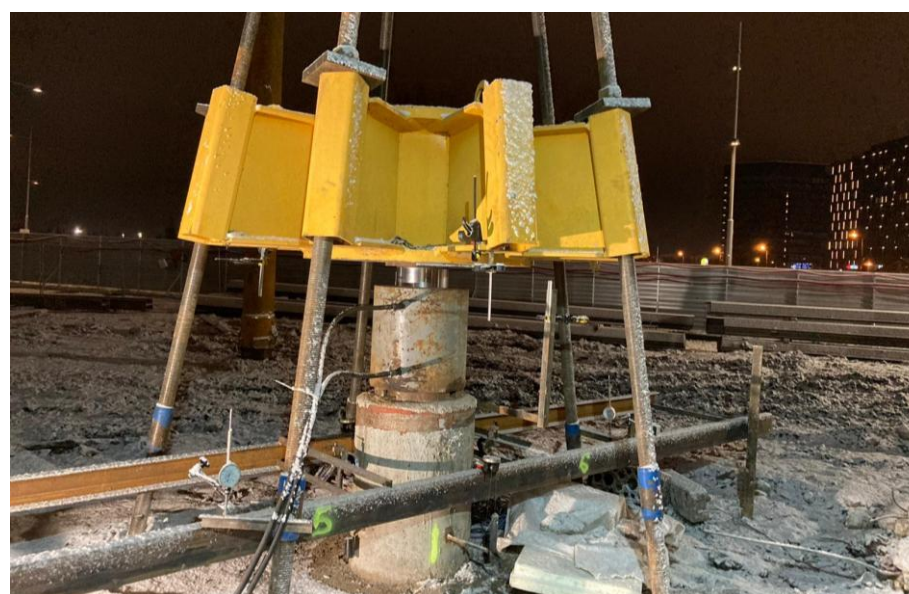
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## Design challenges

### □ Complicated geotechnical conditions 1





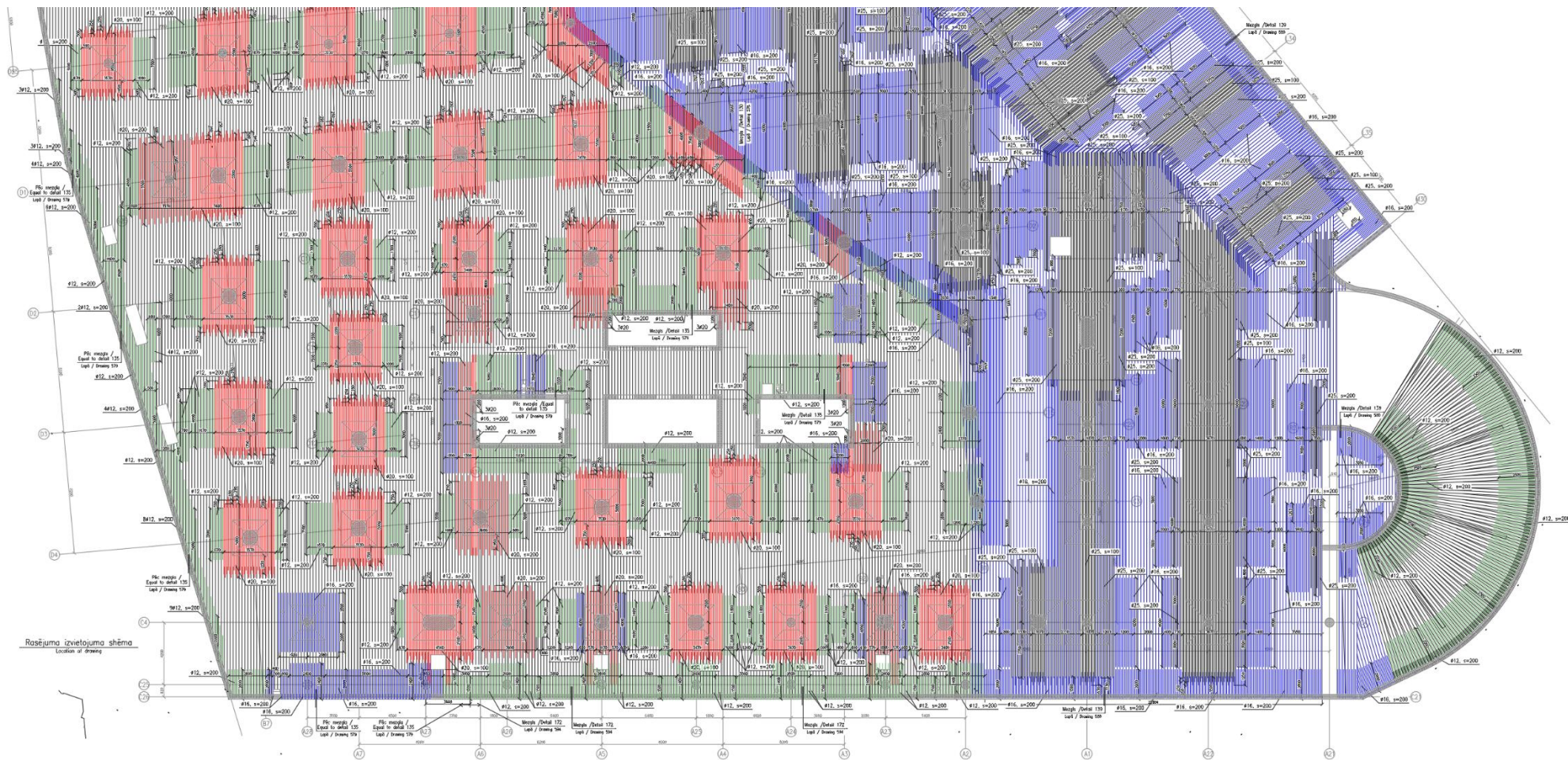
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## Design challenges

- Size, direction, elevation changes, loads in courtyard





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## Construction challenges

- Complicated soil conditions for construction + not easy pile caps





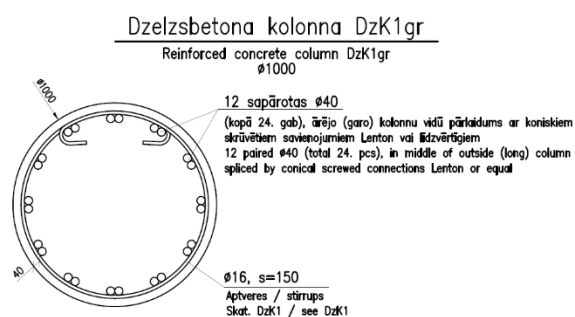
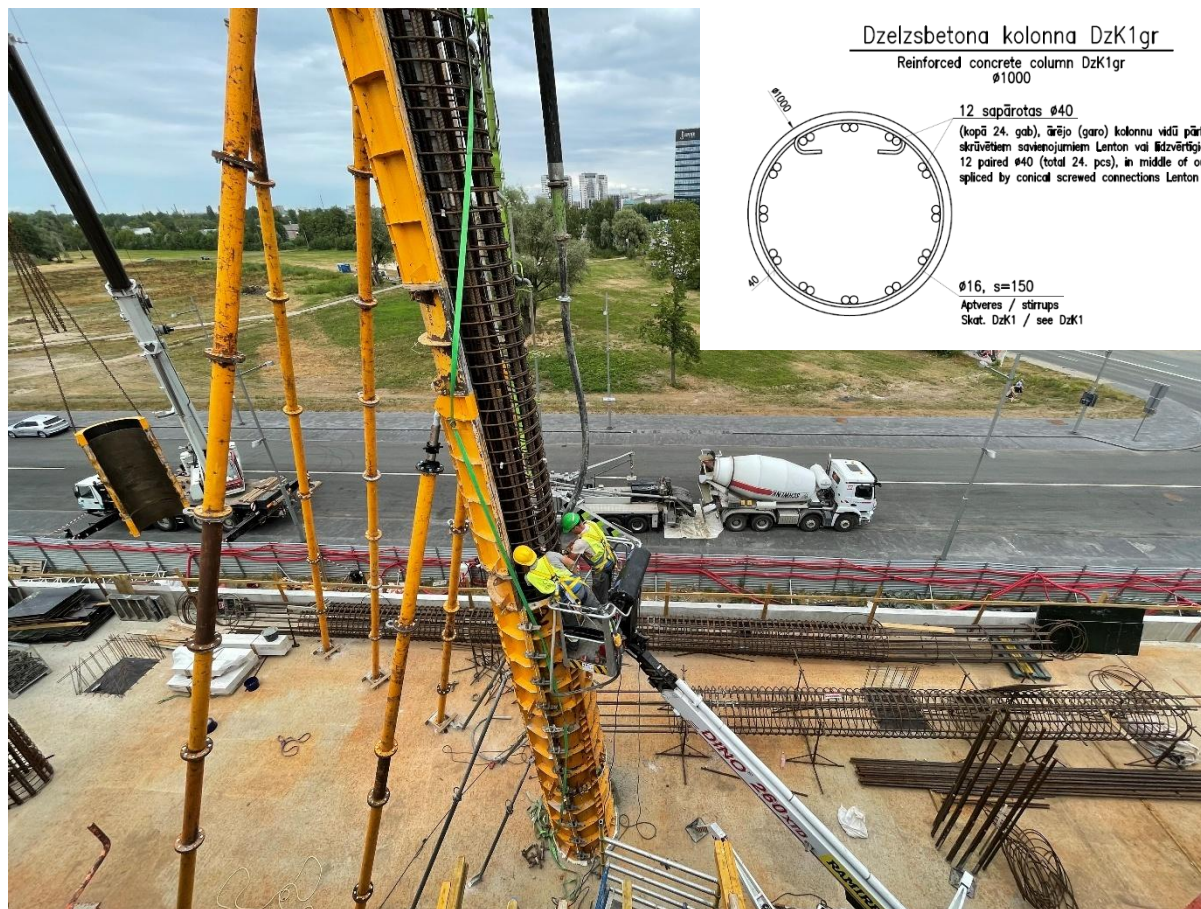
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## Construction challenges

□ 24m d1000mm 10MN columns 24d40+Lenton





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## Construction challenges

- Concreting against hardened concrete C50/60 column bases above foundation slab





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## Construction challenges

### □ Concreting against hardened concrete



# Construction challenges

## □ Concreting against hardened concrete

**LVS EN 1992-1-1:2004**

(6) The total shrinkage strain is composed of two components, the drying shrinkage strain and the autogenous shrinkage strain. The drying shrinkage strain develops slowly, since it is a function of the migration of the water through the hardened concrete. The autogenous shrinkage strain develops during hardening of the concrete: the major part therefore develops in the early days after casting. Autogenous shrinkage is a linear function of the concrete strength. It should be considered specifically when new concrete is cast against hardened concrete. Hence the values of the total shrinkage strain  $\epsilon_{cs}$  follow from

$$\epsilon_{cs} = \epsilon_{cd} + \epsilon_{ca} \quad (3.8)$$

where:

$\epsilon_{cs}$  is the total shrinkage strain  
 $\epsilon_{cd}$  is the drying shrinkage strain  
 $\epsilon_{ca}$  is the autogenous shrinkage strain

The autogenous shrinkage strain follows from:

$$\epsilon_{ca}(t) = \beta_{as}(t) \epsilon_{ca}(\infty) \quad (3.11)$$

where:

$$\epsilon_{ca}(\infty) = 2,5 (f_{ck} - 10) \cdot 10^{-6} \quad (3.12)$$

and

$$\beta_{as}(t) = 1 - \exp(-0,2t^{0,5}) \quad (3.13)$$

where  $t$  is given in days.

**LVS EN 1992-1-1:2023**

### B.3 General

NOTE 1 Both creep and shrinkage are subdivided into two components, basic creep and drying creep or basic shrinkage and drying shrinkage, respectively, due to the pronounced effect of the ambient climate conditions on the magnitude and the kinetics of the time-dependent deformations.

NOTE 2 The drying shrinkage strain develops slowly, since it is a function of the diffusion controlled migration of the water through the hardened concrete, which is affected by the size and shape, and the temperature of the member. The basic shrinkage strain develops during hardening of the concrete: the major part therefore develops in the early days after casting. Basic shrinkage is a function of the water/cement ratio and thus of the concrete strength. It is particularly relevant when new high strength concrete is cast against hardened concrete. For normal strength concrete  $\epsilon_{bs}$  is rather low. For bond between old and new/young concrete total differential shrinkage is relevant (risk of cracking).

where shrinkage is subdivided into the basic shrinkage  $\epsilon_{bs}(t)$  which occurs even if no moisture loss is possible:

$$\epsilon_{cbs}(t) = \epsilon_{cbs,f_{cm}} \cdot \beta_{bs,t} \cdot \alpha_{NDP,b} \quad (B.24)$$

(2) The basic shrinkage  $\epsilon_{bs}(t)$  according to Formula (B.24) may be estimated by applying Formulae (B.26) and (B.27):

$$\epsilon_{cbs,f_{cm}} = \alpha_{bs} \left( \frac{f_{cm,28}}{60 + f_{cm,28}} \right)^{2,5} \cdot 10^{-6} \quad (B.26)$$



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## Construction challenges

□ Concreting against hardened concrete – solution? Additives? Reinforcement?



New EN 206???



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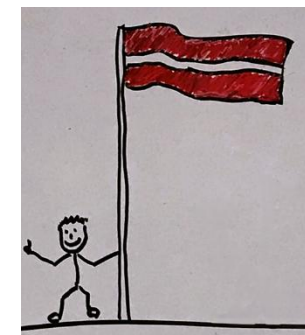
AR  
EN  
SO

Thank you!

AR  
EN  
SO

Team of structural engineers

Riga, Latvia



VERDE  
KLŪST PAR ZALĀKO BIZNESA  
KVARTĀLU LATVIJĀ

Latvijas  
Betona  
Savienība

# Betona loma ēku dzīves cikla novērtējuma aprēķinos un CO<sub>2</sub> emisiju samazināšanas iespējās

Agnese Gaile,

Bonava Baltic Ilgtspējas un procesu vadītāja

27/11/2025

# Šodienas stāsts par rītdienu

Agnese Gaile,  
Bonava Baltic Ilgtspējas un procesu vadītāja  
27/112025

*Betona konstrukcijas ar samazinātu vides nospiedumu*  
Latvijas Betona savienības 33. zinātniski tehniskā konference



  
BONAVA



# Bonava ir viens no vadošajiem mājokļu attīstītājiem Eiropā

Ø

Galvenie 2024. gada rādītāji

Globālā pārstāvniecība

VALSTU SKAITS

6

Bonava mājas

UZSĀKTS BŪVĒT

2035

Bonava mājas

PĀRDOTS

2300

Lokālā pārstāvniecība

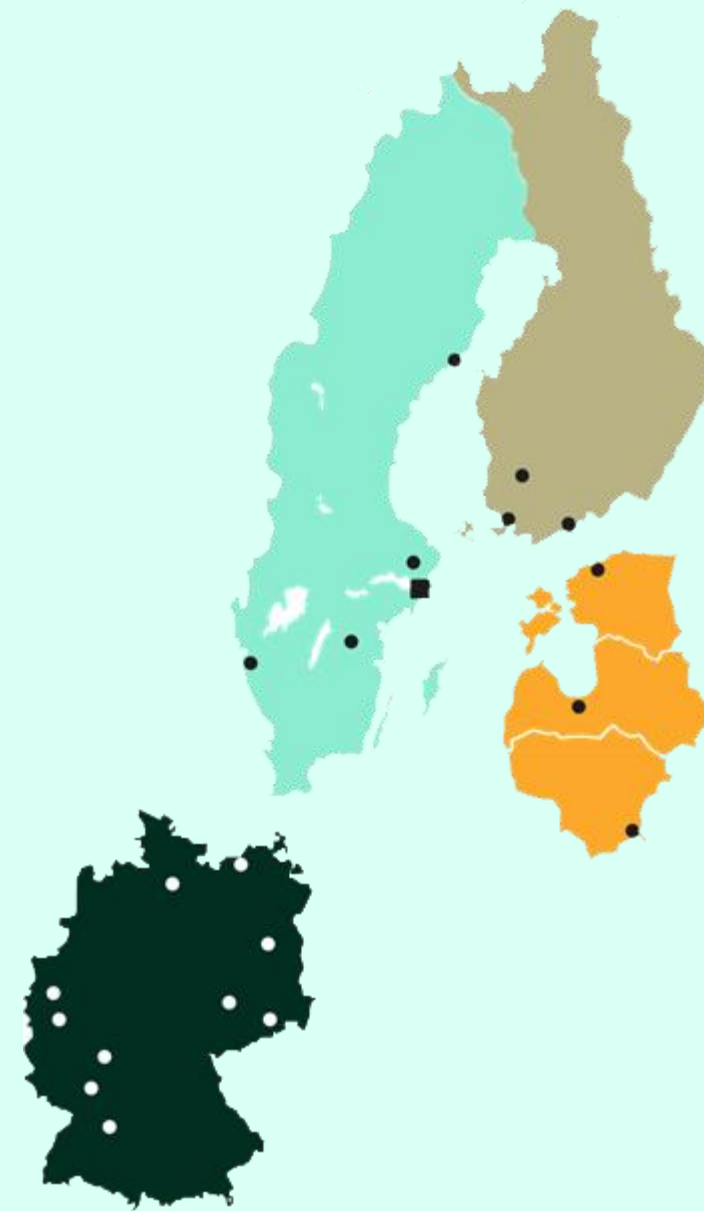
REĢIONU SKAITS

21

Bonava potenciālās mājas

*BUILDING RIGHTS*

25 900



# Baltijā Bonava ir vadošais mājokļu attīstītājs

Kopš 2016. gada Tallinā un Rīgā  
Kopš 2019. gada Viļņā

1

ZEMES IGĀDE

2

PROJEKTA  
IZSTRĀDE

3

MĀRKETINGS &  
PĀRDOŠANA

4

BŪVNICĪBA

5

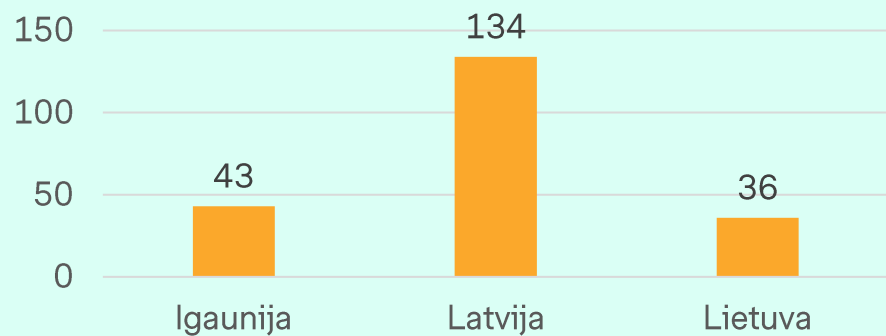
KLIENTU SERVISS



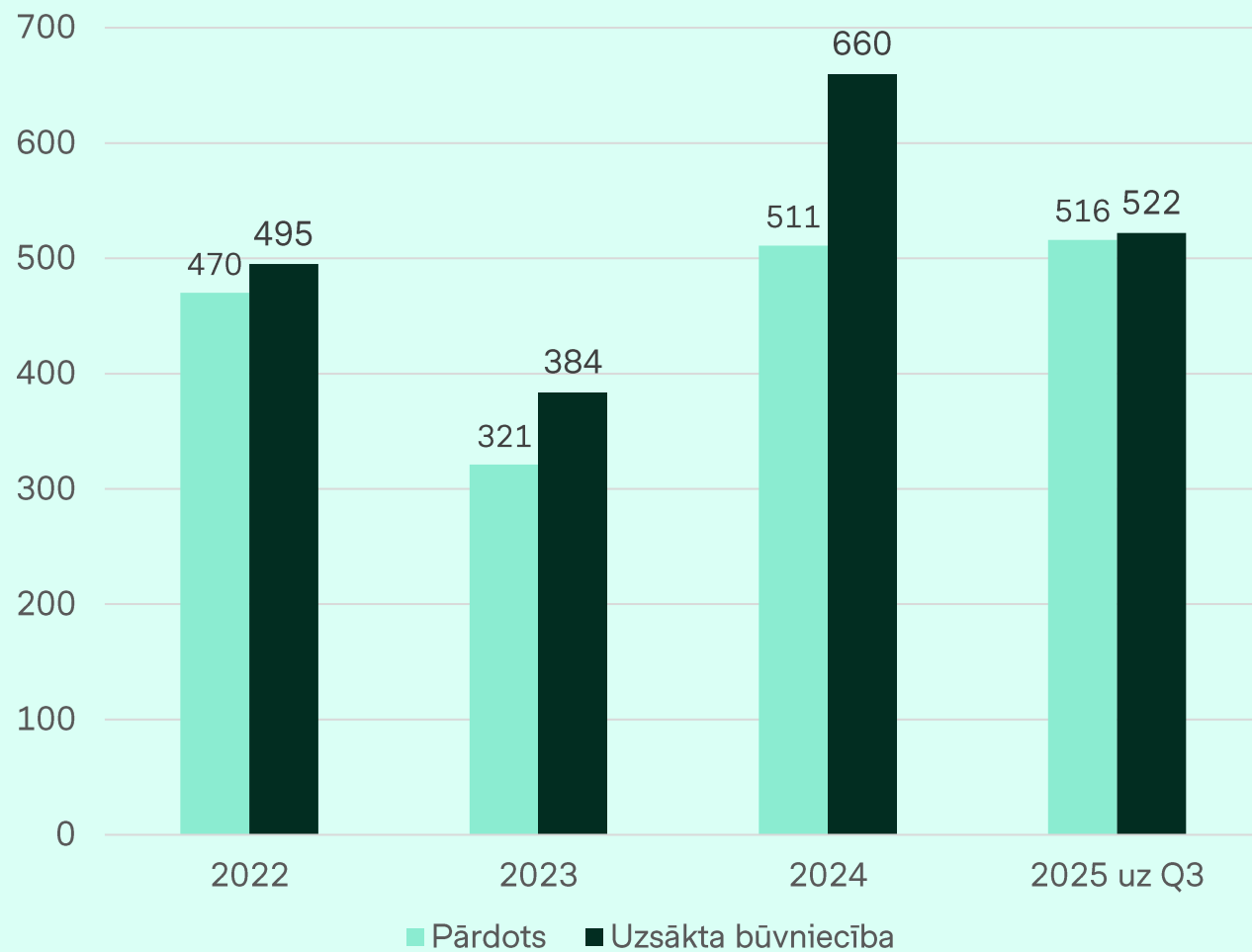
# Bonava Baltijā



Darbinieku skaits



Pārdoto un būvēt uzsākto māju skaits





Mēs radām  
vairāk nekā  
ēkas – mēs  
radām mājas



Mēs radām  
vairāk nekā  
ēkas – mēs  
radām mājas



360 235 M<sup>2</sup>



x33



5094



12 735





# Šodienas stāsts par rītdienu

- Bonava emisiju samazināšanas mērķi
- Pieredze, izpēte un atklājumi
- Bonava + betons = ?
- Ko mēs sagaidām no ražotājiem





## 2030 vs 2024

## RAŽOTĀJI UN PIEGĀDATĀJI

Bonava apņemas samazināt 3. tvēruma SEG emisijas uzceltajās ēkās par **40,8%** uz m<sup>2</sup>



**TVĒRUMS 3: BŪVNICĪBA**  
46% no visām emisijām

## BONAVA

Bonava apņemas samazināt 1. un 2. tvēruma SEG emisijas par **42 %**



**TVĒRUMS 1 & 2: PAŠU PATĒRĪŠ**  
1% no visām emisijām

## KLIENTI

Bonava apņemas samazināt 3. tvēruma SEG emisijas, kas radīsies uzcelto ēku lietošanas laikā, par **51,6%** uz m<sup>2</sup>



**TVĒRUMS 3: LIETOŠANA**  
53% no visām emisijām

## Kas ir dzīves cikla novērtējums jeb LCA?

- LCA ir metodika, lai novērtētu un sniegtu holistisku priekšstatu par produktu un pakalpojumu ietekmi uz vidi visā to dzīves cikla laikā
- Dzīves cikla posmi: sākot no izejvielu ieguves līdz iznīcināšanai vai pārstrādei



### A1 – A3 Product stage

- A1** Raw material extraction
- A2** Transport to manufacturing site
- A3** Manufacturing

### A4 – A5 Construction stage

- A4** Transport to construction site
- A5** Installation / Assembly

### B1 – B5 Use stage

- B1** Use
- B2** Maintenance
- B3** Repair
- B4** Replacement
- B5** Refurbishment
- B6** Operational energy use
- B7** Operational water use

### C1 – C4 End of life stage

- C1** Deconstruction & demolition
- C2** Transport
- C3** Waste processing
- C4** Disposal



## Bonava ēku LCA

- Ārējo ekspertu *CarbonTrust* apstiprinātas
  - Bonava ēkas (produkta) definīcija, tvērums un detalizācija
  - Bonava vadlīnijas LCA aprēķināšanai
- *OneClickLCA* platforma dzīves cikla aprēķiniem
  - Specific EPD
  - Generic EPD
  - Bonava datu bāze ar EPD
- Kopš 2024. gada LCA aprēķins tiek veikts pilnīgi visām pabeigtajām ēkām, izmantojot platformu *OneClickLCA*



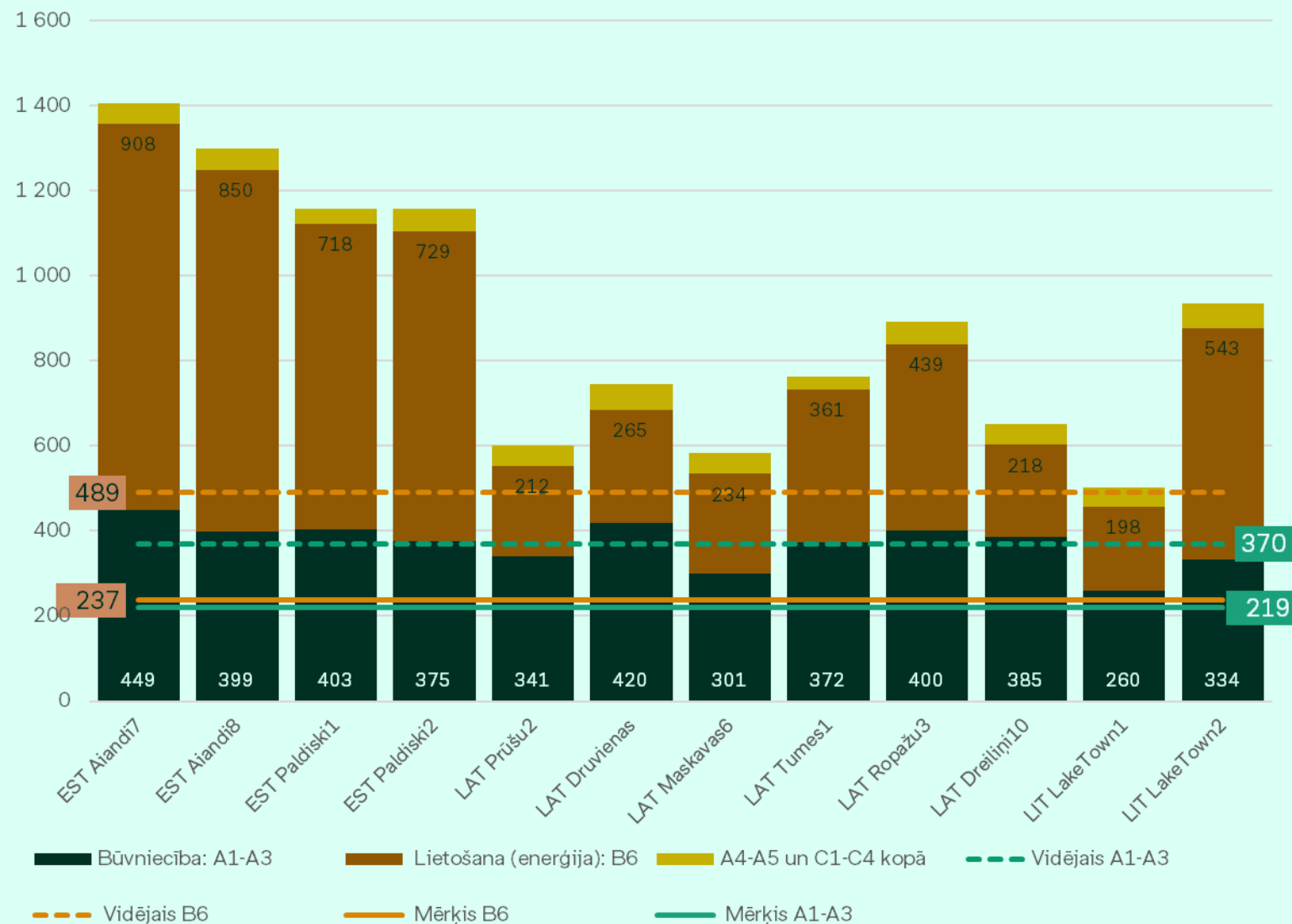
Šampētera kvartāls



## Ko mēs ieraudzījām LCA

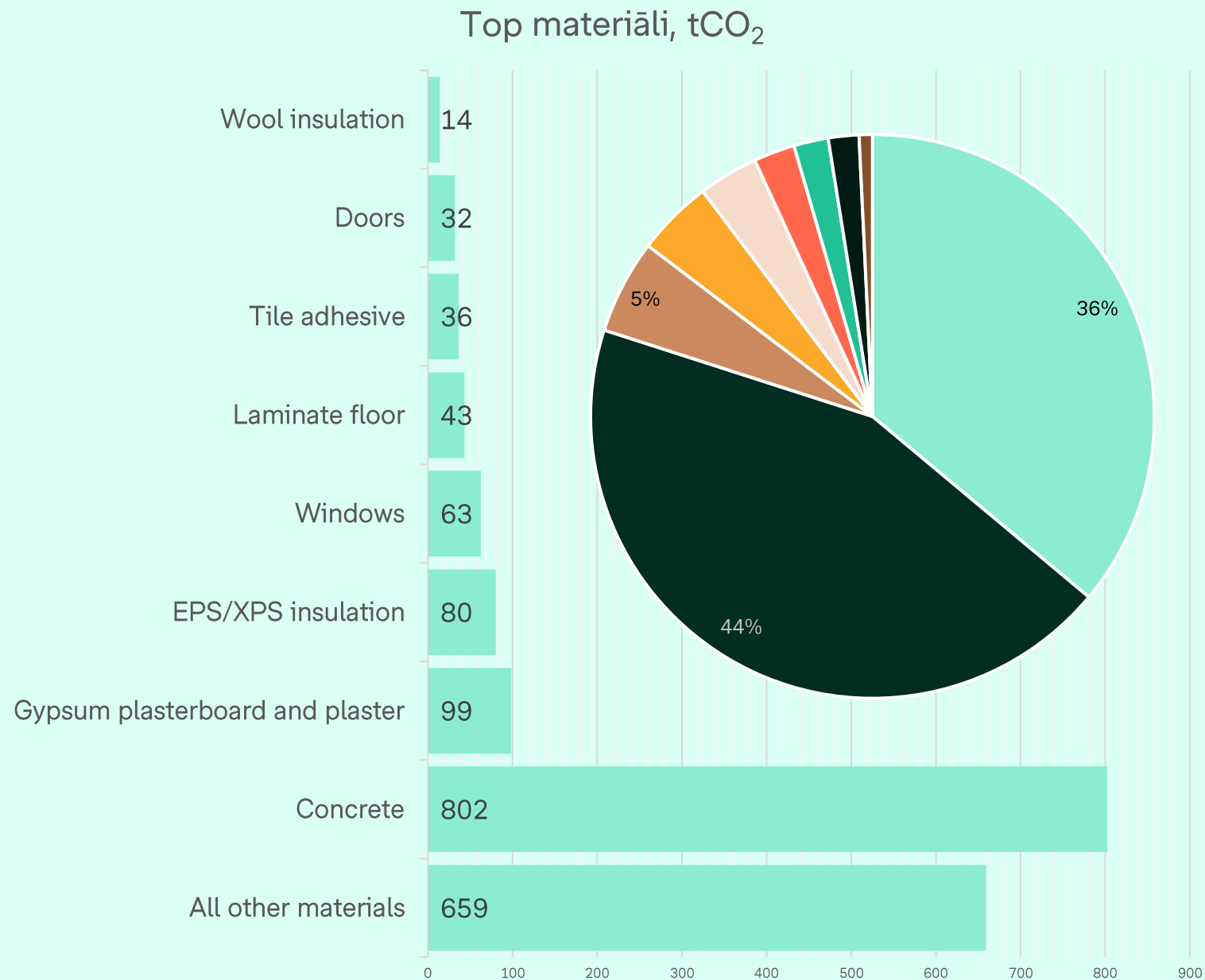
- Enerģija lietošanas laikā
  - Siltums
  - Elektrība
- Būvniecības materiāli
  - Betons
  - Ģipškartons un ģipša apmetums

Emisijas Bonava ēkās CO<sub>2</sub>e kg/m<sup>2</sup> pa dzīves cikla posmiem un ambīcijas emisiju samazināšanā līdz 2030. gadam



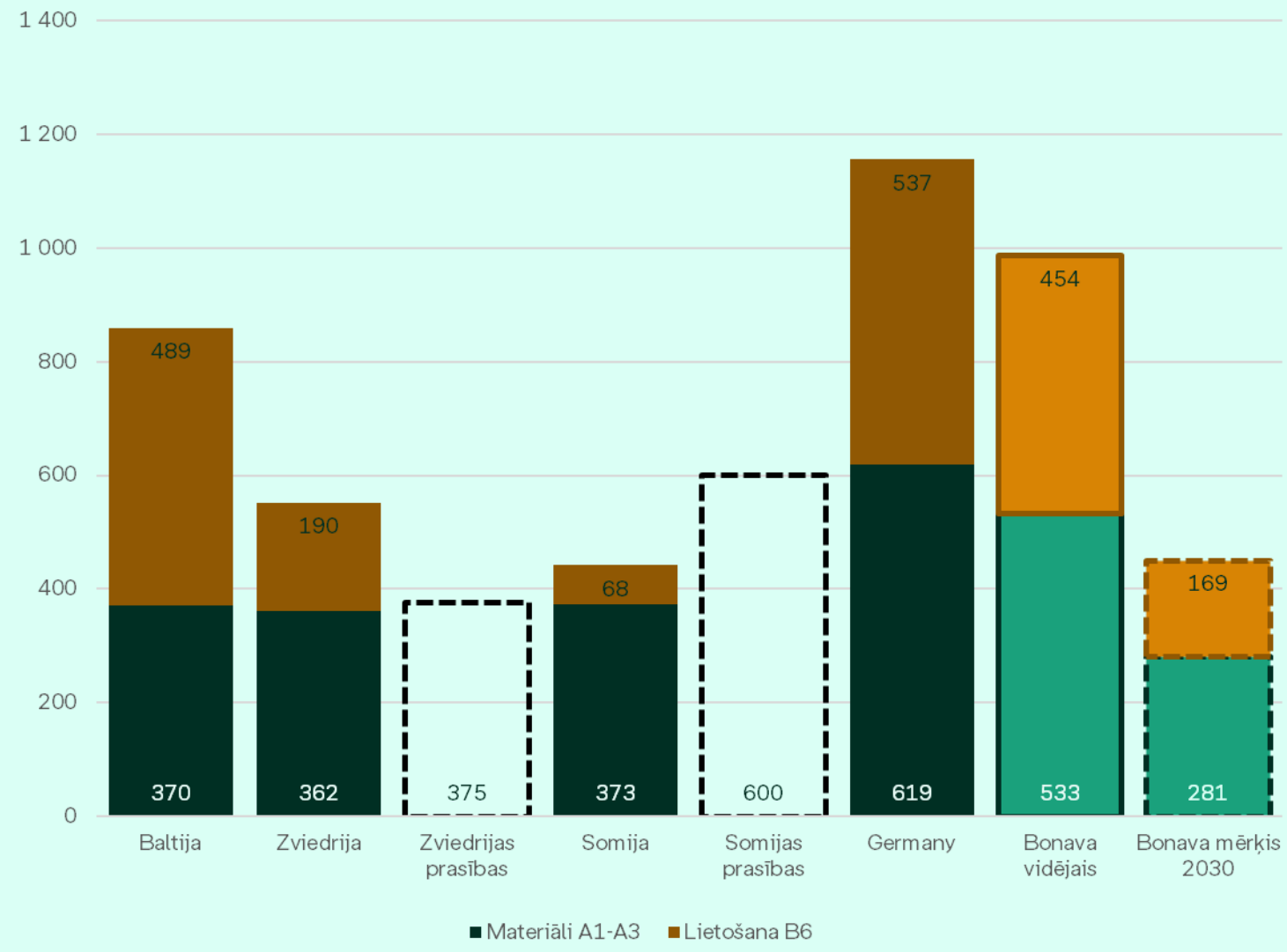
## Ko LCA mums atklāja

- Betons
  - Pāļi
  - Pamati
  - Pārsegumi
  - Sienas
  - Grīdas
- Ģipškartons un ģipša apmetums



Kā izskatāmies salīdzinājumā  
ar citām Bonava valstīm

Emisijas pa valstīm Bonava ēkās CO<sub>2</sub>e kg/m<sup>2</sup> un ambīcijas emisiju samazināšanā





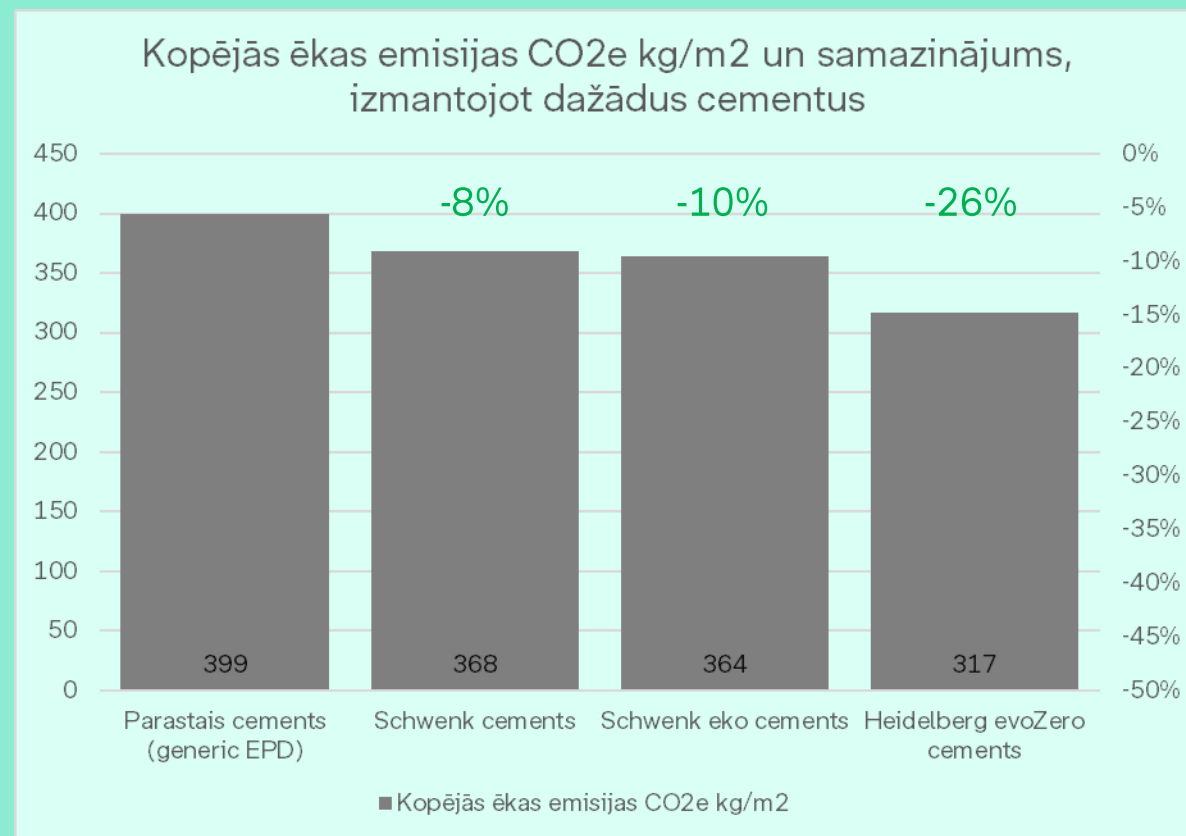
## Emisiju samazinājuma iespējas meklējot

- Darba grupa
  - Testa projekts
  - *Building System*
  - Visas idejas akceptētas
  - Tikšanās un sarunas ar ražotājiem un piegādātājiem
  - Emisiju un izmaksu aprēķins
  - Atklājumi un secinājumi
- 
- Reālāko ideju atlase dziļākai izpētai
  - Emisiju samazinašanas jeb pārejas uz zemāku emisiju produktiem ieviešanas plāns





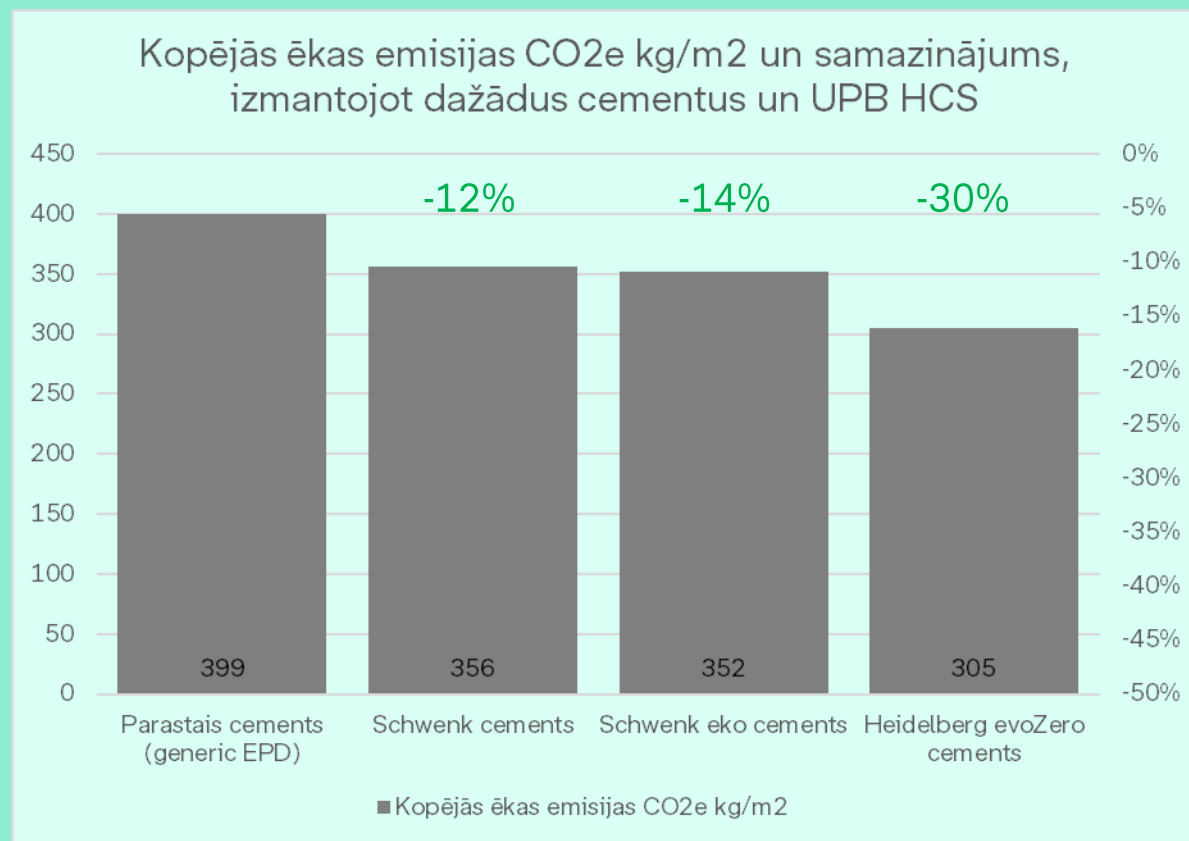
## Emisiju samazinājuma iespējas betonā



Čiekuru mājas



## Emisiju samazinājuma iespējas betonā



Vertikāles



# Izaicinājumi

DAUDZFAKTORU  
IETEKME  
IZMAKSAS  
PRASĪBAS

DATI  
INFORMĀCIJA  
SADARBĪBA

# Galvenie secinājumi

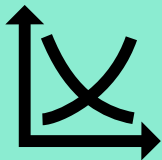
Bonava būvē un turpinās  
būvēt no betona, lai radītu  
**daudz laimīgu māju**



# Ko mēs sagaidām no ražotājiem



IZMAKSU LĪDZSVARS



EPD IR SVARĪGS UN VAJADZĪGS



KOPĪGIE MĒRĶI





# Paldies!

Bonava  
27/11/2025

Nīcgaļes mājas





**JAUNAS METODIKAS NĀKOŠĀS PAAUDZES**

**2. EIROKODEKSĀ BETONA KONSTRUKCIJU ILGTSPĒJAI**

**NEW METHODOLOGIES FOR NEXT-GENERATION  
CONCRETE SUSTAINABILITY IN EUROCODE 2**

NORMUNDS TIRĀNS

SIA “IG Kurbads” biroja vadītājs, būvinženieris



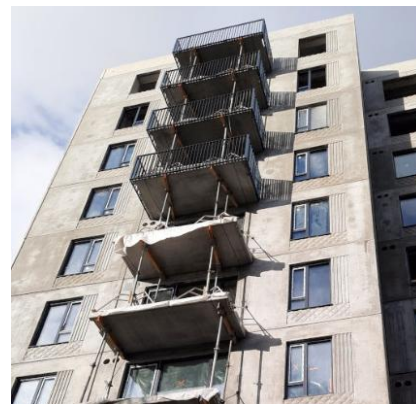
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Dailes teātra pārbūve



Rēzeknes "Zeimuļs"



Zunda Towers



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# **Annex I**

(informative)

## **Assessment of Existing Structures**

**‘The greenest building is the one that already exists’**

- link to EN13791 and explicit provisions for calculating  $f_{ck}$  from cores obtained on site;
- more detailed (favourable) determination of strength reduction factor for sustained loading;
- explicit relationships for determining of strength of reinforcement from testing of samples from existing structures;

## **Annex A** (informative)

### **Adjustment of partial factors for materials**

NOTE 3 The values given in Table I.1 (NDP) and Table I.2 (NDP) are derived assuming a target reliability index  $\beta_{tgt} = 3,8$ . If a different target value is used (see EN 1990), the values in Table I.1 (NDP) and Table I.2 (NDP) can be rearranged. For a target reliability index  $\beta_{tgt} < 3,8$  the values in the tables are conservative.

NOTE 4 For the adjustment of partial factors for materials, see Annex A.

**Table I.1 (NDP) — Values of  $V_{fc, is, lim}$  as function of the number of test results  $n$**

| $n^a$                                                                                  | 8    | 10   | 12   | 16   | 20   | 30   | $\infty$ |
|----------------------------------------------------------------------------------------|------|------|------|------|------|------|----------|
| $V_{fc, is, lim}$                                                                      | 0,13 | 0,15 | 0,17 | 0,20 | 0,21 | 0,23 | 0,29     |
| <sup>a</sup> $n$ is the number of test results available for the evaluated test region |      |      |      |      |      |      |          |

**Table I.2 (NDP) — Values of  $V_{fy, lim}$  as function of the number of test results  $n$**

| $n$           | 5     | 8     | 10    | 12    | 16    | 20    | 30    | $\infty$ |
|---------------|-------|-------|-------|-------|-------|-------|-------|----------|
| $V_{fy, lim}$ | 0,025 | 0,050 | 0,060 | 0,065 | 0,080 | 0,085 | 0,095 | 0,120    |





- guidance on dealing with corrosion penetration when determining effective cross sections for capacity calculations;
- Full Critical Shear Crack theory for determining shear capacity;
- some methods for historic issues in detailing that mean existing structures don't comply with the new standard;
- a method for calculation anchorage length for plain bars :

$$\frac{l_{bd}}{\phi} = (130\eta_1) \cdot \left(\frac{\gamma_c}{1,5}\right)^{\frac{3}{2}\eta_2} \cdot \left(\frac{\sigma_{sd}}{435}\right)^{\frac{5}{4}\eta_3} \cdot \left(\frac{25}{f_{ck}}\right)^{\frac{2}{3}\eta_4} \cdot \left(\frac{1,5\phi}{c_d}\right) \geq 10$$

**Annex J**  
(informative)

**Strengthening of Existing Concrete Structures with CFRP**

**Annex L**  
(informative)

**Steel Fibre Reinforced Concrete Structures**

**Annex M**  
(normative)

**Lightweight aggregate concrete structures**



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## Annex N (informative)

### Recycled aggregates concrete structures

a) For reinforced concrete:

- 1) when the substitution rate of recycled aggregates (quantity of fine and coarse recycled aggregates/total quantity of aggregates)  $\alpha_{RA} \leq 0,20$  there is no change in the mechanical properties;
- 2) when  $0,20 < \alpha_{RA} \leq 0,40$  the values of properties in Table N.1 should be used or values should be determined by testing;
- 3) when  $\alpha_{RA} > 0,40$  the properties in Table N.1 should be determined by testing using an identified batch of aggregates.



### 5.1.3 Strength

(1) The compressive strength of concrete shall be denoted by concrete strength classes which relate to the characteristic (5 %) cylinder strength  $f_{ck}$  of the concrete in accordance with EN 206, determined at an age  $t_{ref}$ .

(2) The value for  $t_{ref}$

a) should be taken as 28 days in general; or

b) may be taken between 28 and 91 days when specified for a project.

It is pointed out that the characteristic strength  $f_{ck}$  is the strength value for the reference age  $t_{ref}$  which should be taken as 28 days in general or may be taken between 28 and 91 days when specified for a project [1]. This varying reference age is associated with several implications in terms of different concrete properties and parameters, respectively, which are originally derived from the characteristic strength at the concrete age of 28 days.

The strength values  $f_{ck}$ , and  $f_{cm}$  refer to a specified reference age  $t_{ref}$  in the range of  $28 \text{ days} \leq t_{ref} \leq 91 \text{ days}$ , which means that the indices ck and cm may no longer be associated with the values at the age of 28 days as this was the case for EN 1992-1-1:2004/AC:2010-11. This is particularly important for all equations describing deformations, i.e. the elastic strain, creep and shrinkage. If the characteristic or mean value of strength at the age of 28 days is to be applied in a given formula, the concrete strength shall be clearly referred to as  $f_{ck,28}$  and  $f_{cm,28}$ .

### 3. Key changes in Eurocode 2, EN 1992-1-1

#### Clause 6 Durability and concrete cover - EN 1992-1-1:

- Clause 6 introduces new performance-based approach for durability design:  
Effects of exposure of member (t)  $\leq$  Exposure-resistance of member (t) as  $f(\beta)$ .
- Effect of exposure over time (t) considered with recognised models for carbonation and chloride ingress (e.g. *fib* Model Codes).
- Resistance of concrete is grouped into Exposure Resistance Classes (ERC):
  - for new types of concrete (without sufficient experience) or all types based on performance testing acc. to EN 12390-xy or national test procedures
  - for known types of concrete (with sufficient experience) can be determined based on deemed-to-satisfy rules

→ proof of conformity according to EN 206-100 (under preparation).
- ERC-Concept currently developed for corrosion of reinforcement in carbonated concrete and induced by chlorides (future extension to freeze-thaw, chemical attack, etc.).

**Table 6.3 (NDP) — Minimum concrete cover  $c_{\min, \text{dur}}$  for carbon reinforcing steel — Carbonation**

| ERC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Exposure class (carbonation) |     |     |     |     |     |     |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----|-----|-----|-----|-----|-----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | XC1                          |     | XC2 |     | XC3 |     | XC4 |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Design service life (years)  |     |     |     |     |     |     |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 50                           | 100 | 50  | 100 | 50  | 100 | 50  | 100 |
| XRC 0,5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10                           | 10  | 10  | 10  | 10  | 10  | 10  | 10  |
| XRC 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 10                           | 10  | 10  | 10  | 10  | 15  | 10  | 15  |
| XRC 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 10                           | 15  | 10  | 15  | 15  | 25  | 15  | 25  |
| XRC 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 10                           | 15  | 15  | 20  | 20  | 30  | 20  | 30  |
| XRC 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 10                           | 20  | 15  | 25  | 25  | 35  | 25  | 40  |
| XRC 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 15                           | 25  | 20  | 30  | 25  | 45  | 30  | 45  |
| XRC 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 15                           | 25  | 25  | 35  | 35  | 55  | 40  | 55  |
| XRC 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 15                           | 30  | 25  | 40  | 40  | 60  | 45  | 60  |
| <p>NOTE 1 XRC classes for resistance against corrosion induced by carbonation are derived from the carbonation depth [mm] (characteristic value 90 % fractile) assumed to be obtained after 50 years under reference conditions (400 ppm CO<sub>2</sub> in a constant 65 %-RH environment and at 20 °C). The designation value of XRC has the dimension of a carbonation rate [mm/√ (years)].</p> <p>NOTE 2 The recommended minimum concrete cover values <math>c_{\min, \text{dur}}</math> assume execution and curing according to EN 13670 with at least execution class 2 and curing class 2.</p> <p>NOTE 3 The minimum covers can be increased by an additional safety element <math>\Delta c_{\text{dur}, \gamma}</math> considering special requirements (e.g. more extreme environmental conditions).</p> |                              |     |     |     |     |     |     |     |





**Table 6.4 (NDP) — Minimum concrete cover  $c_{\min, \text{dur}}$  for carbon reinforcing steel — Chlorides**

| ERC      | Exposure class (chlorides)  |     |     |     |     |     |                             |     |     |     |     |     |
|----------|-----------------------------|-----|-----|-----|-----|-----|-----------------------------|-----|-----|-----|-----|-----|
|          | XS1                         |     | XS2 |     | XS3 |     | XD1                         |     | XD2 |     | XD3 |     |
|          | Design service life (years) |     |     |     |     |     | Design service life (years) |     |     |     |     |     |
|          | 50                          | 100 | 50  | 100 | 50  | 100 | 50                          | 100 | 50  | 100 | 50  | 100 |
| XRDS 0,5 | 20                          | 20  | 20  | 30  | 30  | 40  | 20                          | 20  | 20  | 30  | 30  | 40  |
| XRDS 1   | 20                          | 25  | 25  | 35  | 35  | 45  | 20                          | 25  | 25  | 35  | 35  | 45  |
| XRDS 1,5 | 25                          | 30  | 30  | 40  | 40  | 50  | 25                          | 30  | 30  | 40  | 40  | 50  |
| XRDS 2   | 25                          | 30  | 35  | 45  | 45  | 55  | 25                          | 30  | 35  | 45  | 45  | 55  |
| XRDS 3   | 30                          | 35  | 40  | 50  | 55  | 65  | 30                          | 35  | 40  | 50  | 55  | 65  |
| XRDS 4   | 30                          | 40  | 50  | 60  | 60  | 80  | 30                          | 40  | 50  | 60  | 60  | 80  |
| XRDS 5   | 35                          | 45  | 60  | 70  | 70  | —   | 35                          | 45  | 60  | 70  | 70  | —   |
| XRDS 6   | 40                          | 50  | 65  | 80  | —   | —   | 40                          | 50  | 65  | 80  | —   | —   |
| XRDS 8   | 45                          | 55  | 75  | —   | —   | —   | 45                          | 55  | 75  | —   | —   | —   |
| XRDS 10  | 50                          | 65  | 80  | —   | —   | —   | 50                          | 65  | 80  | —   | —   | —   |

NOTE 1 XRDS classes for resistance against corrosion induced by chloride ingress are derived from the depth of chlorides penetration [mm] (characteristic value 90 % fractile), corresponding to a reference chlorides concentration (0,6 % by mass of binder (cement + type II additions)), assumed to be obtained after 50 years on a concrete exposed to one-sided penetration of reference seawater (30 g/l NaCl) at 20 °C. The designation value of XRDS has the dimension of a diffusion coefficient [ $10^{-13} \text{ m}^2/\text{s}$ ].

NOTE 1 XRC classes for resistance against corrosion induced by carbonation are derived from the carbonation depth [mm] (characteristic value 90 % fractile) assumed to be obtained after 50 years under reference conditions (400 ppm CO<sub>2</sub> in a constant 65 %-RH environment and at 20 °C). The designation value of XRC has the dimension of a carbonation rate [mm/√ (years)].

NOTE 1 XRDS classes for resistance against corrosion induced by chloride ingress are derived from the depth of chlorides penetration [mm] (characteristic value 90 % fractile), corresponding to a reference chlorides concentration (0,6 % by mass of binder (cement + type II additions)), assumed to be obtained after 50 years on a concrete exposed to one-sided penetration of reference seawater (30 g/l NaCl) at 20 °C. The designation value of XRDS has the dimension of a diffusion coefficient [10<sup>-13</sup> m<sup>2</sup>/s].



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| class   | Carbonation depth (90% fractile) in mm at 50 years (reference conditions) |
|---------|---------------------------------------------------------------------------|
| XRC 0,5 | 3,5                                                                       |
| XRC 1   | 7                                                                         |
| XRC 2   | 14                                                                        |
| XRC 3   | 21                                                                        |
| XRC 4   | 28                                                                        |
| XRC 5   | 35                                                                        |
| XRC 6   | 42                                                                        |
| XRC 7   | 49                                                                        |

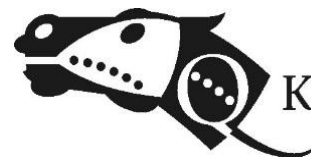
Tentative deemed-to-satisfy provisions deriving from EN206 Table F1 that would ensure “smooth continuity” with the most current XRC classes

| Exposure resistance class | Present corresp. max w/c | Present corresp. min. strength |
|---------------------------|--------------------------|--------------------------------|
| <b>XRC4</b>               | 0,5                      | C30/37                         |
| <b>XRC5</b>               | 0,55                     | C30/37                         |
| <b>XRC6</b>               | 0,6                      | C25/30                         |
| <b>XRC7</b>               | 0,65                     | C20/25                         |



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NOTE 2 An informative Annex P provides an alternative approach to design cover for durability without use of Exposure Resistance Classes (ERC) based on EN 1992-1-1:2004. The use of ERC according to 6.4 applies unless the National Annex specifies use of Annex P..

## **Annex P** **(informative)**

### **Alternative cover approach for durability**

#### **P.1 Use of this Informative Annex**

(1) This Informative Annex provides an alternative approach to design cover for durability without use of Exposure Resistance Classes (ERC) as defined in 6.4. In this case, the resistance of the cover depends on the value of concrete cover and the concrete mix requirements based on Deemed-to-Satisfy values for the limiting values of concrete composition according to EN 206:2013, Annex F (see P.3).

NOTE National choice on the application of this Informative Annex is given in the National Annex. If the National Annex contains no information on the application of this Informative Annex, it can be used.

#### **P.2 Scope and field of application**

(1) This Informative Annex applies to the design of cover for durability of concrete without the use of Exposure Resistance Classes (ERC) as defined in 6.4.

(2) Except for 6.4, 6.5.2.1(1) and 6.5.2.2, all provisions of Clause 6 apply.



XC3  
min C30/37  
 $C_{min, dur} = 20\text{mm}$

or

for example :  
XRC6  
min - C25/30  
 $C_{min, dur} = 35\text{mm}$



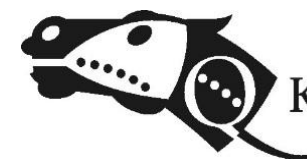
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**Table 6.3 (NDP) — Minimum concrete cover  $c_{\min, \text{dur}}$  for carbon reinforcing steel — Carbonation**

| ERC     | Exposure class (carbonation) |     |     |     |     |     |     |     |
|---------|------------------------------|-----|-----|-----|-----|-----|-----|-----|
|         | XC1                          |     | XC2 |     | XC3 |     | XC4 |     |
|         | Design service life (years)  |     |     |     |     |     |     |     |
|         | 50                           | 100 | 50  | 100 | 50  | 100 | 50  | 100 |
| XRC 0,5 | 10                           | 10  | 10  | 10  | 10  | 10  | 10  | 10  |
| XRC 1   | 10                           | 10  | 10  | 10  | 10  | 15  | 10  | 15  |
| XRC 2   | 10                           | 15  | 10  | 15  | 15  | 25  | 15  | 25  |
| XRC 3   | 10                           | 15  | 15  | 20  | 20  | 30  | 20  | 30  |
| XRC 4   | 10                           | 20  | 15  | 25  | 25  | 35  | 25  | 40  |
| XRC 5   | 15                           | 25  | 20  | 30  | 25  | 45  | 30  | 45  |
| XRC 6   | 15                           | 25  | 25  | 35  | 35  | 55  | 40  | 55  |
| XRC 7   | 15                           | 30  | 25  | 40  | 40  | 60  | 45  | 60  |



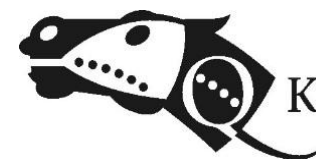


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