MasterCO₂re™ for Low-clinker Concrete Production

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1. Clinker reduction in concrete and main consequences
2. MasterCO₂re™: Intelligent mechanism of action
3. Achieving “Sustainable Concrete Performance”
Cement is the main source of CO₂ emissions in concrete

- Only ~ 10% by volume but ...
- More than 90% of the CO₂ emissions!
- Cement/Clinker reduction is a necessary measure to make construction more sustainable in the future
How to reduce clinker in concrete?

**Cement type**
Use cements with a lower clinker amount

**Cement dosage**
Reduce cement amount in concrete

**Blending**
Replace partially cement with SCMs
Clear trend in switching to lower clinker cement types … but at the same time, cement dosage is increased to retrieve performance!

Limited clinker and CO$_2$ reduction per m$^3$ of concrete

Impacts on concrete performance

- Workability retention
  - Significant loss
- Rheology
  - Higher viscosity
- Strength development
  - Loss of strength at early and late stage

How to reduce these impacts?

- Clear trend in switching to lower clinker cement types …
- … but at the same time, cement dosage is increased to retrieve performance!
- Limited clinker and CO$_2$ reduction per m$^3$ of concrete
1. Clinker reduction in concrete and main consequences

2. MasterCO₂re™: Intelligent mechanism of action

3. Achieving “Sustainable Concrete Performance”
New superplasticizer solution for low-clinker concrete

- Workability
- Rheology
- Strength

MasterCO$_2$re™
MasterCO$_2$re™: Intelligent Cluster System (ICS) Technology

Key features

- ICS is based on a unique technology that smartly creates clusters of finely tuned chemical structures.
- Part of the polymers are freely available, not clustered.
- Polymers of specifically designed chemical structures are held together in clusters of defined dimensional distributions.
- The matrix of the cluster is the core of the technology enabling a controlled release of the polymers according to the properties of the cementitious system.
Intelligent Cluster System (ICS)

Workability retention

- When ICS is in a cementitious matrix, triggered by the increasing pH, by the specific ionic species in the pore solution, the polymers are released in a controlled way.

- Controlled release: the polymers are partially detached from the cluster and the cluster gets smaller and emptier.

- The controlled release of polymers guarantees superior workability retention.
Intelligent Cluster System (ICS)

**Rheology**

- The dimension and the steric hindrance of the clusters, compared to usual polycarboxylates, ensure an advanced rheology level.

- The viscosity is lower at time=$0$ and stays lower because of the controlled release and the dimensional distribution of the clusters.

The clusters provide a kind of tribological/lubrication effect.
Intelligent Cluster System (ICS)

**Strength Development**

- The controlled release does not retard
  - excellent early strength development

- The controlled release allows a more orderly growth of hydration crystals and a lower porosity
  - excellent long-term strength development

BET of hydrated pastes – dimension of pores and overall porosity

TGA – Thermo gravimetric analysis

SEM – Scanning electron microscope

XRD – X-Ray Diffractometer

Confirm an enhanced degree of hydration and a more compact structure
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Application case 1 (MasterCO$_2$re™)

<table>
<thead>
<tr>
<th>Materials</th>
<th>Reference mix 1</th>
<th>Reference mix 2</th>
<th>Low-clinker mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand 0/4mm (kg/m$^3$)</td>
<td>950</td>
<td>950</td>
<td>965</td>
</tr>
<tr>
<td>Gravel d.max 20mm (kg/m$^3$)</td>
<td>780</td>
<td>780</td>
<td>790</td>
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<tr>
<td>Limestone filler (kg/m$^3$)</td>
<td>100</td>
<td>50</td>
<td>80</td>
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<tr>
<td>CEM I 52.5 R (kg/m$^3$)</td>
<td>400</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CEM II/A-LL 52.5 R (kg/m$^3$)</td>
<td>-</td>
<td>450</td>
<td>420</td>
</tr>
<tr>
<td>Water (kg/m$^3$)</td>
<td>190</td>
<td>190</td>
<td>175</td>
</tr>
<tr>
<td>Conventional SP (kg/m$^3$)</td>
<td>3.0</td>
<td>3.6</td>
<td>-</td>
</tr>
<tr>
<td>MasterCO$_2$re™ (kg/m$^3$)</td>
<td>-</td>
<td>-</td>
<td>3.6</td>
</tr>
<tr>
<td>W/C</td>
<td>0.48</td>
<td>0.42</td>
<td>0.42</td>
</tr>
</tbody>
</table>

GWP tot (kg CO$_2$eq/m$^3$) 389 380 (-2.3%) 360 (-7.4%)

Water saved for daily consumption of * 0 people 0 people (-0.0%) 4 people (-7.9%)

*Assumption per person = 3.5l/day
## Application case 2 (MasterCO$_2$re™ + Master X-Seed)

<table>
<thead>
<tr>
<th>Materials</th>
<th>Reference mix</th>
<th>Low-clinker mix</th>
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</thead>
<tbody>
<tr>
<td>Sand (kg/m$^3$)</td>
<td>914</td>
<td>954</td>
</tr>
<tr>
<td>Gravel 8/19mm (kg/m$^3$)</td>
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<td>773</td>
</tr>
<tr>
<td>Limestone filler (kg/m$^3$)</td>
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<td>130</td>
</tr>
<tr>
<td>CEM I 52.5 R (kg/m$^3$)</td>
<td>400</td>
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</tr>
<tr>
<td>CEM II/A-LL 52.5 R (kg/m$^3$)</td>
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<td>370</td>
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<tr>
<td>Water (kg/m$^3$)</td>
<td>190</td>
<td>175</td>
</tr>
<tr>
<td>Conventional SP (kg/m$^3$)</td>
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<tr>
<td>MasterCO$_2$re™ (kg/m$^3$)</td>
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<td>Master X-Seed (kg/m$^3$)</td>
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<td>3.7</td>
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<tr>
<td>W/C</td>
<td>0.48</td>
<td>0.47</td>
</tr>
</tbody>
</table>

- **GWP tot (kg CO$_2$eq/m$^3$)**: 388, 315 (-18.8%)
- **Water saved for daily consumption of ***: 0 people, 4 people (-7.9%)

*Assumption per person = 3.5l/day
Landing page
