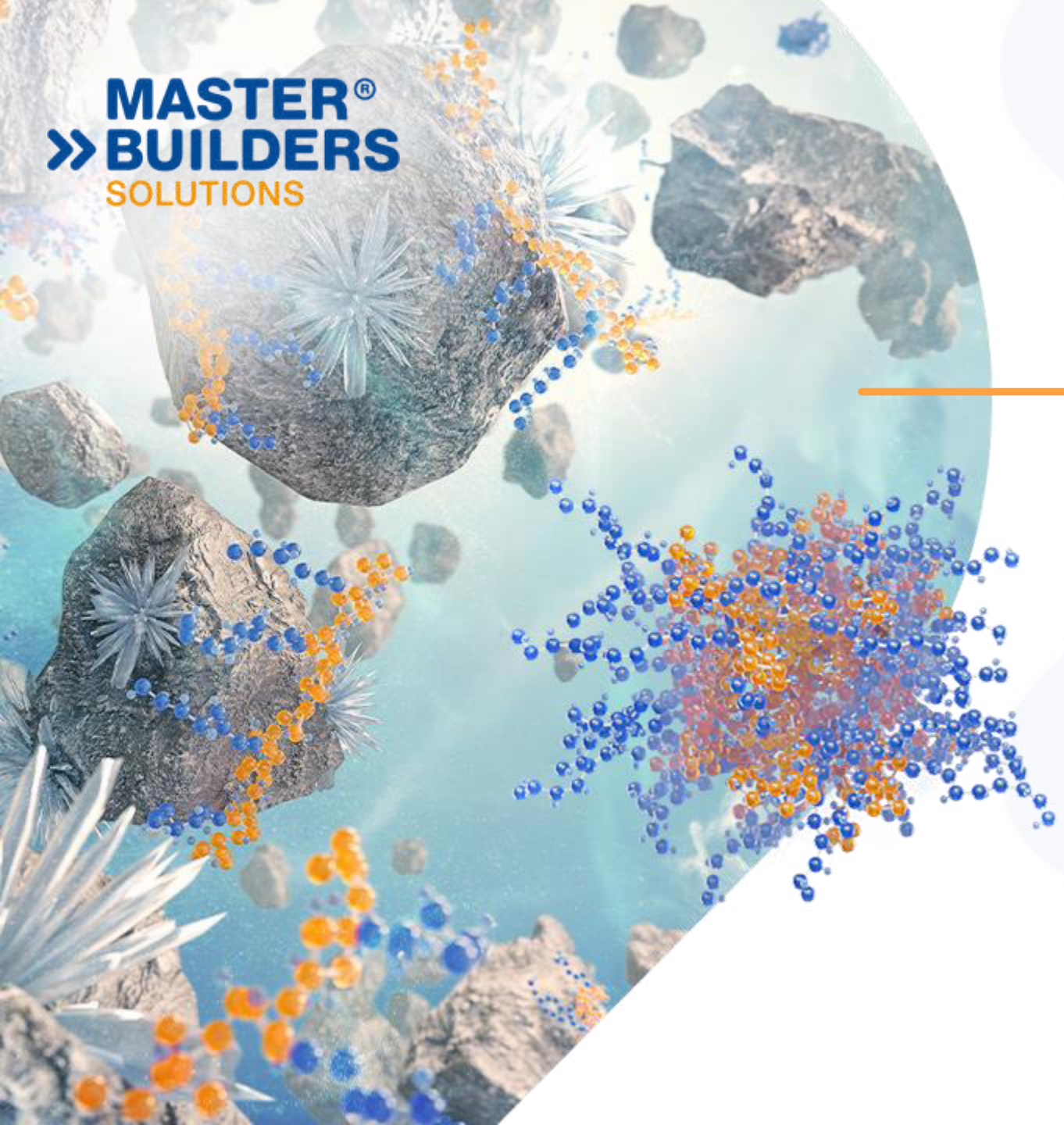


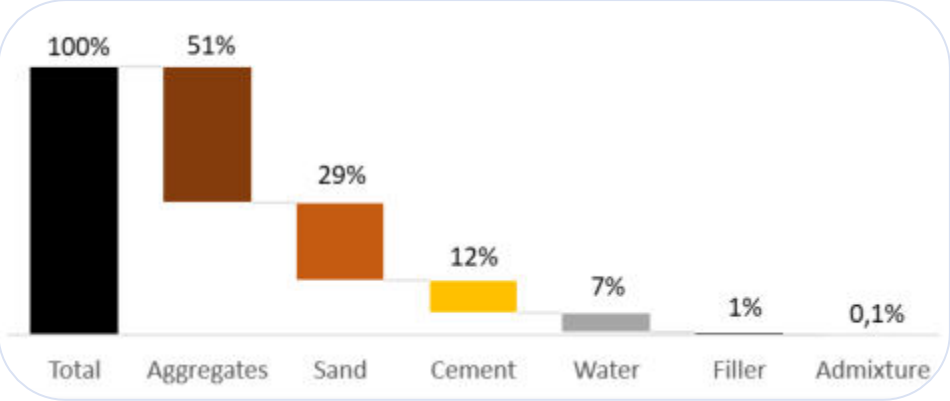
MasterCO$_2$re™ for Low-clinker Concrete Production

Gaetano Guarino
Customer Segment Manager Precast & MCP Europe
BIBM Congress Amsterdam
28 September 2023

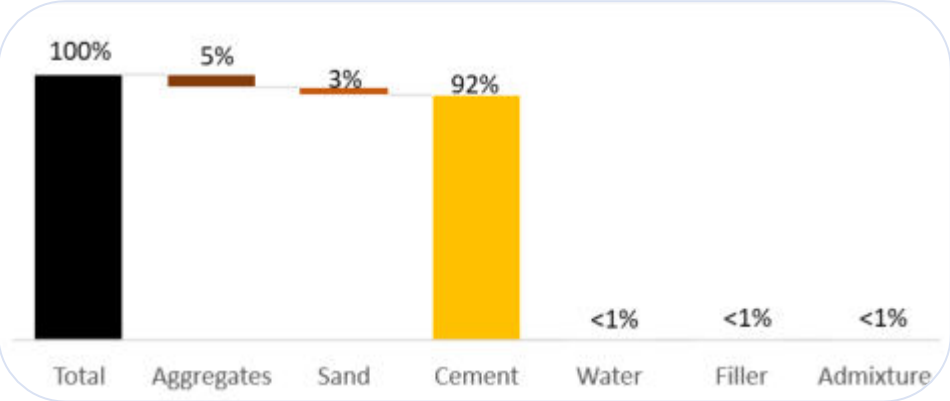
Agenda

1. Clinker reduction in concrete and main consequences
2. MasterCO$_2$re™ : Intelligent mechanism of action
3. Achieving “Sustainable Concrete Performance”

Composition of a m^3 concrete (% by volume)



Contribution to CO_2 emissions of concrete



Cement is the main source of CO_2 emissions in concrete

- Only ~ 10% by volume but …
- More than 90% of the CO_2 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

Clinker reduction in 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

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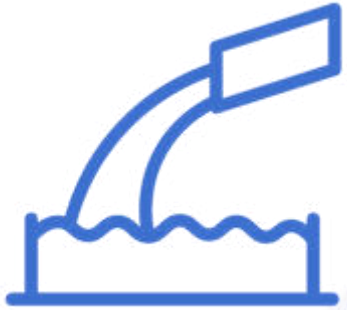
New superplasticizer solution for low-clinker concrete

Workability



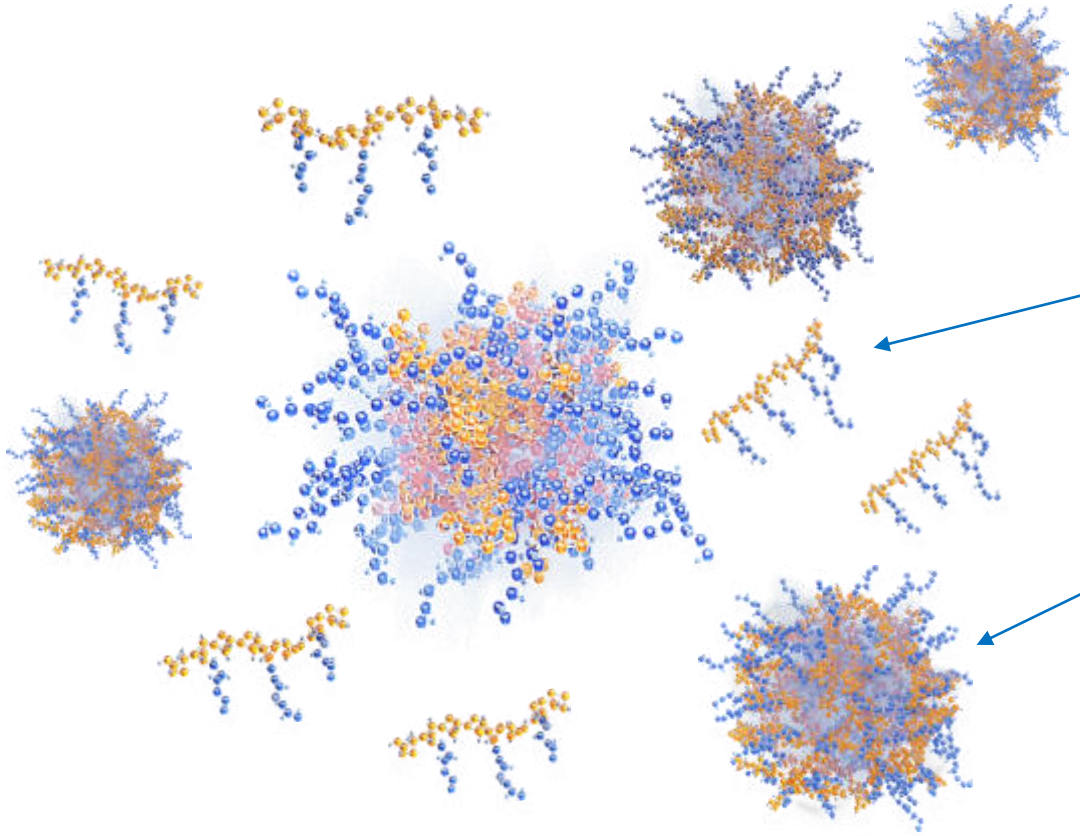
Rheology

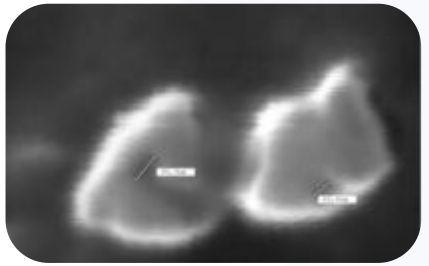
Strength

MasterCO$_2$re™

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

Key features

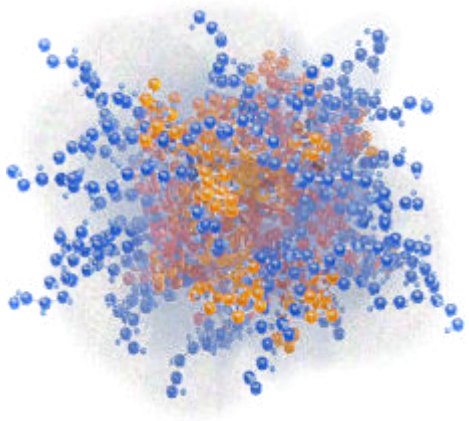




- ICS is based on a unique technology that smartly creates clusters of finely tuned chemical structures
- Part of the polymers are freely available, not clustered
- Polymers of specifically designed chemical structures are held together in clusters of defined dimensional distributions
- The matrix of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

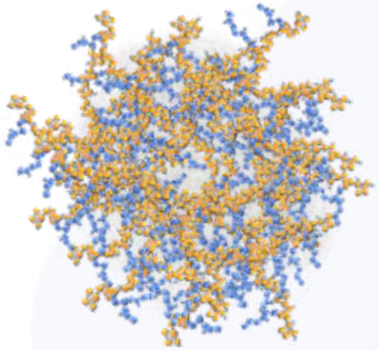
Intelligent Cluster System (ICS)

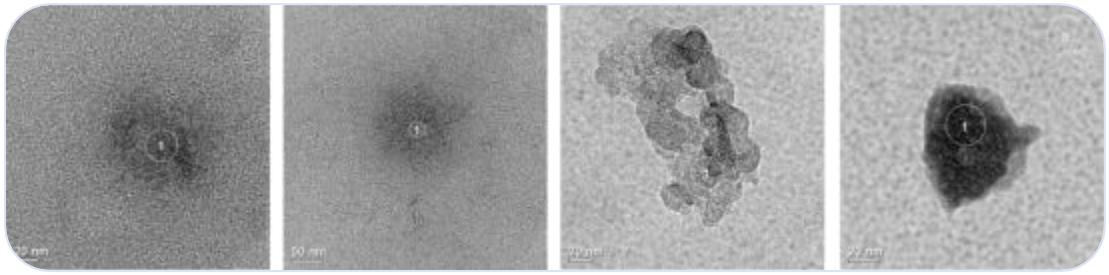
Workability retention



- 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

pH, pore solution composition





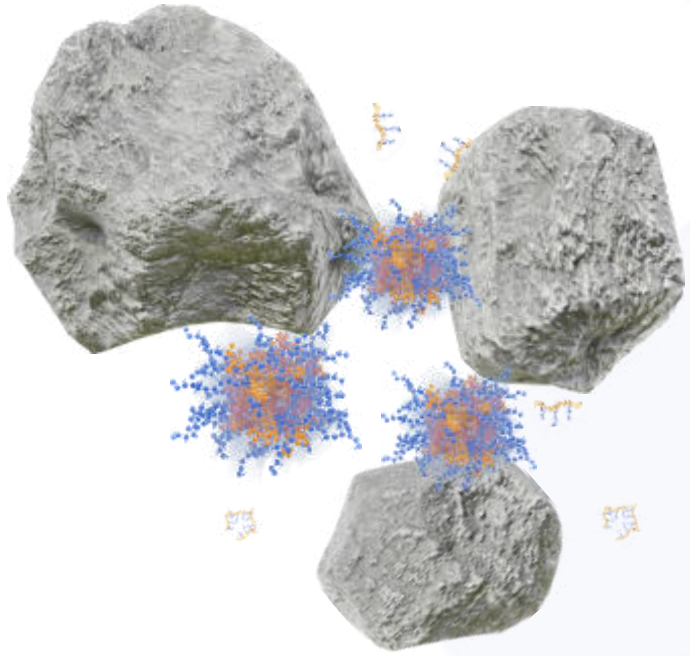
- Controlled release: the polymers are partially detached from the cluster and the cluster gets smaller and emptier
- The controlled release of polymers guarantees superior workability retention

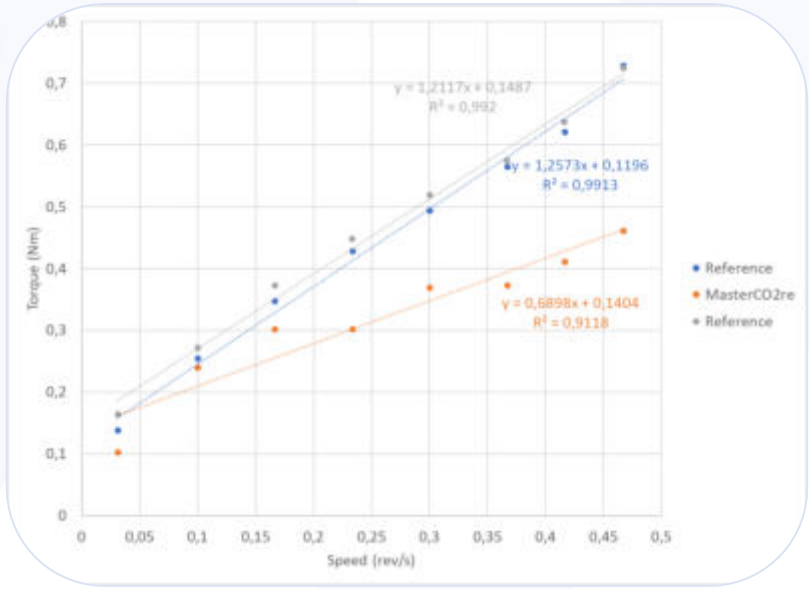
Intelligent Cluster System (ICS)

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

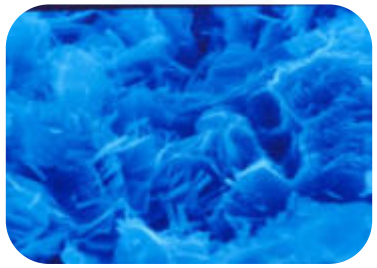
BET of hydrated pastes – dimension of pores and overall porosity

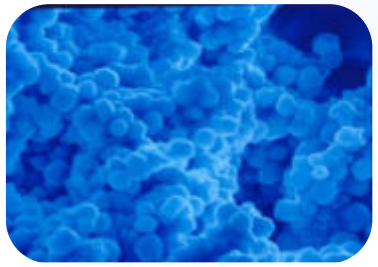
TGA – Thermo gravimetric analysis

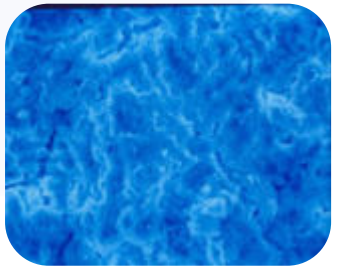
SEM – Scanning electron microscope

XRD – X-Ray Difrattometer

Confirm an enhanced degree of hydration and a more compact structure







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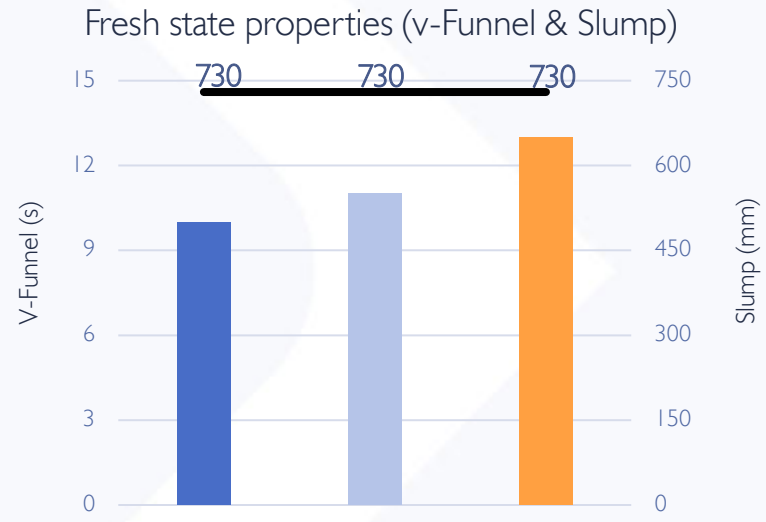
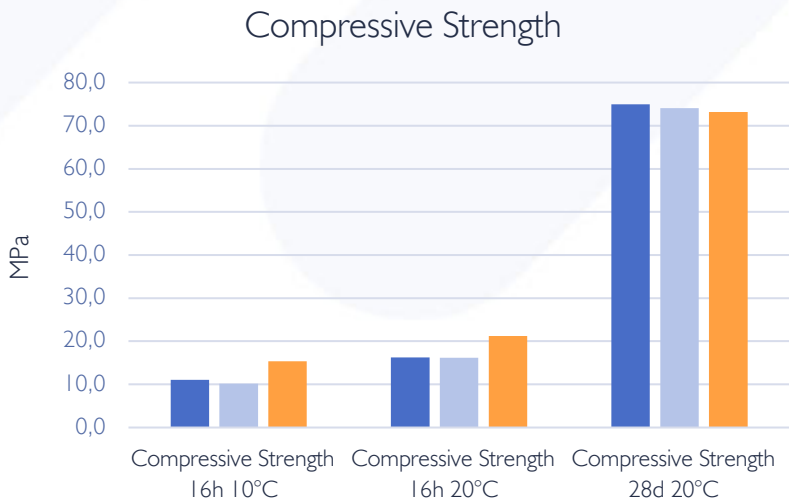
Application case 1 (MasterCO$_2$re™)

Materials	Reference mix 1	Reference mix 2	Low-clinker mix
Sand 0/4mm (kg/m^3)	950	950	965
Gravel d.max 20mm (kg/m^3)	780	780	790
Limestone filler (kg/m^3)	100	50	80
CEM I 52,5 R (kg/m^3)	400	-	-
CEM II/A-LL 52,5 R (kg/m^3)	-	450	420
Water (kg/m^3)	190	190	175
Conventional SP (kg/m^3)	3.0	3.6	-
MasterCO$_2$re™ (kg/m^3)	-	-	3,6
W/C	0.48	0.42	0.42

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)

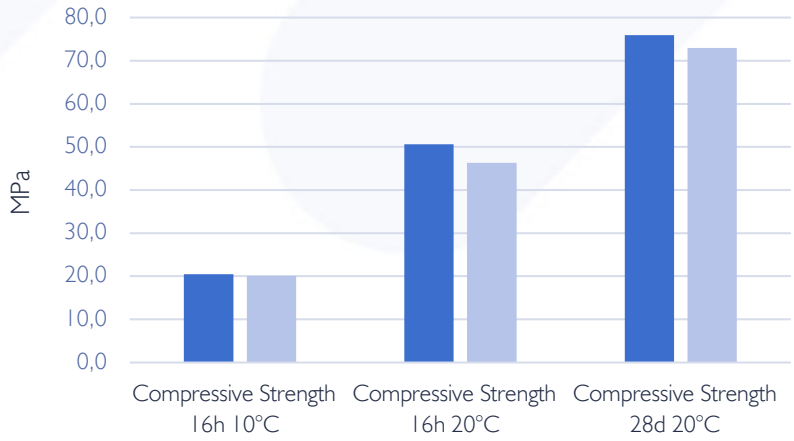
Materials	Reference mix	Low-clinker mix
Sand (kg/m^3)	914	954
Gravel 8/19mm (kg/m^3)	747	773
Limestone filler (kg/m^3)	100	130
CEM I 52,5 R (kg/m^3)	400	-
CEM II/A-LL 52,5 R (kg/m^3)	-	370
Water (kg/m^3)	190	175
Conventional SP (kg/m^3)	3.2	-
MasterCO$_2$re™ (kg/m^3)	-	2.6
Master X-Seed (kg/m^3)	-	3.7
W/C	0.48	0.47

GWP tot (kg CO$_2$eq/m^3)	388	315 (-18,8%)
Water saved for daily consumption of *	0 people	4 people (-7,9%)

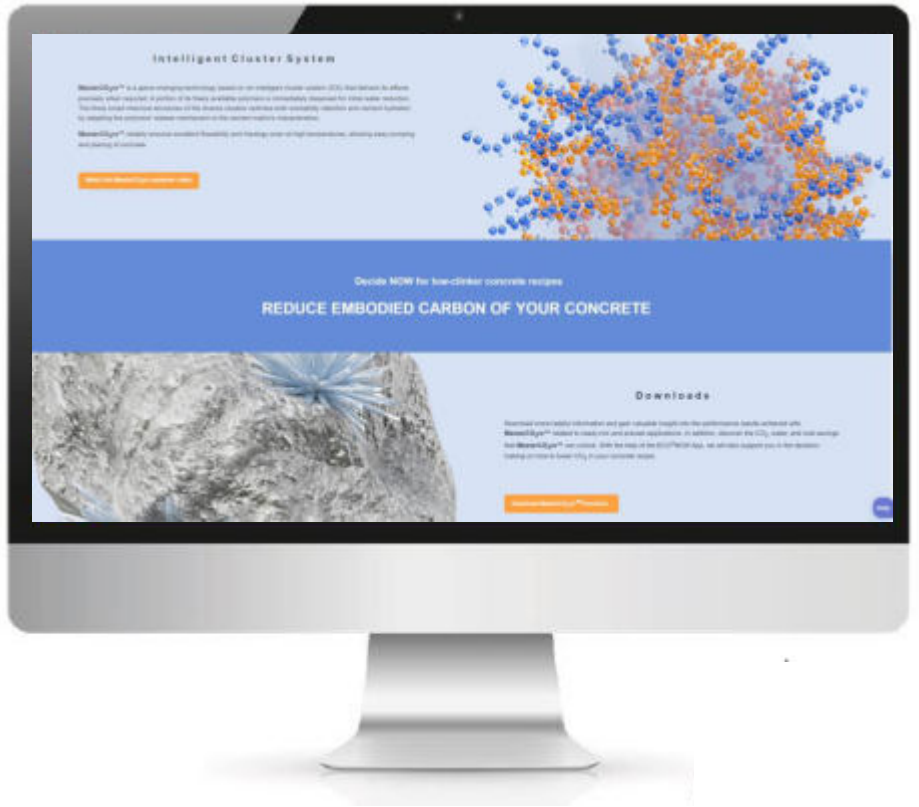
*Assumption per person = 3,5l/day

Fresh state properties (v-Funnel & Slump)

Compressive Strength



Landing page



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