



Reducing Carbon Through Innovative Technology

Leveraging Holcim's Digital Innovation To Reduce Carbon

NRMCA Concrete Innovations – October 18, 2023
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HOLCIM US: DRIVEN BY OUR PURPOSE BUILDING PROGRESS FOR PEOPLE AND THE PLANET

MAKING CITIES GREENER

from foundation to rooftop with low carbon solutions



EMPOWERING SOCIETY WITH SMARTER INFRASTRUCTURE

from green mobility and renewable energy to essential sanitation



IMPROVING LIVING STANDARDS FOR ALL

with affordable and sustainable solutions



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AT THE FOREFRONT OF GREEN BUILDING SOLUTIONS

 13 cement plants	 -250 RMX, aggregate, asphalt sites	 +7,000 employees	 43 states	Leading US Cement producer	
 Net Zero pledge	 SBTi validated 2030 targets	 ESG Rankings from MSCI to Sustainalytics	 Green Solutions 1/3 of our sales		Leading the way in sustainability
 Circular Economy	 50 million tons materials recycled annually	 Alternative fuels diverting materials from landfills	 Geocycle & Systech reduce and recycle		



SMART READY-MIX CONCRETE SOLUTIONS

Leveraging digital technologies to enable informed data driven decisions

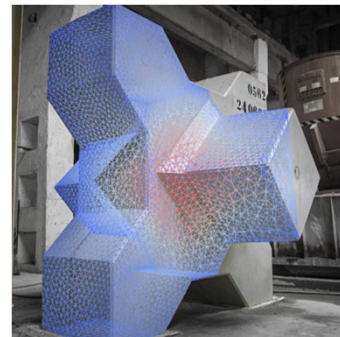
PUMPING SIMULATOR



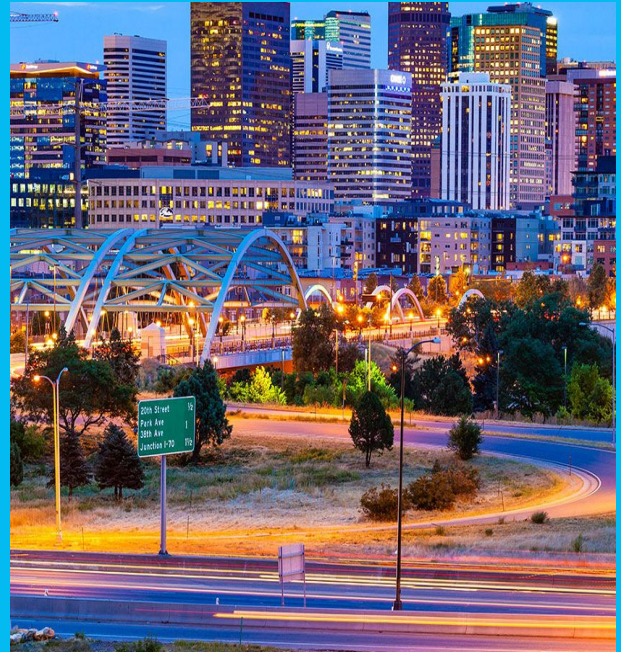
MATURITY MONITORING



THERMAL - CURING TEMPERATURE



SMARTFLOW - SUCCESS IN COLORADO



CONCRETE PUMPING PREDICTION TOOL - SMARTFLOW

Long distance, vertical and horizontal pumping simulation



- Ensure pumping feasibility in complex situations
- Assist in selection of the most suitable pump
- Optimize mix design to reduce pump pressure and GWP
- Typical segments: High Rise & Infrastructure



A US FIRST AT A COLORADO DISTRIBUTION CENTER PROJECT

Using SMARTFLOW Technology to optimize concrete pumpability and CO2

Place:
Northern CO

Building type:
e-commerce distribution center with robotic slabs

Date:
2022-2023

Height:
5 floors

Pumping distance:
300' to 700' horizontal - up to 75' vertical

Volume:
97,000
Approx. CY



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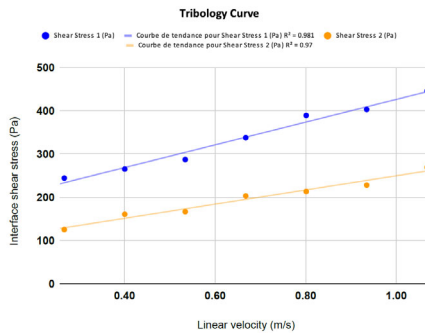


A US FIRST AT A COLORADO DISTRIBUTION CENTER PROJECT

Tribometer study step-by-step



Tribometer to perform measurements with the actual concrete mix



Output ⇒ key parameters for prediction

PIPELINE	
Elevation (m)	23 75 Feet Vertical
Section 1	
Pipe diameter (mm)	125 5" Pipe
Pipe length (m)	31 101 Feet Through the Pump
Number Elbows 90° - 250 mm radius	18
Number Elbows 90° - 1000 mm radius	1
Number Elbows 45° - 1000 mm radius	2
Number Elbows 90° - 2000 mm radius	2
Section 2	
Pipe diameter (mm)	125 5" Pipe
Pipe length (m)	110 360 Feet Horizontal System
Number Elbows 90° - 250 mm radius	70
Number Elbows 90° - 1000 mm radius	1
Number Elbows 90° - 1000 mm radius	1
Section 3	
Pipe diameter (mm)	101.6 4" Pipe
Pipe length (m)	31 102 Feet Horizontal System
Number Elbows 90° - 250 mm radius	70
Number Elbows 90° - 1000 mm radius	1
Number Elbows 90° - 1000 mm radius	1
Summary	
Pump Power (kW)	298.28
Min. pressure in pipe mode (bars)	70
Min. pressure in piston mode (bars)	150
Min. pressure in piston mode (bars)	0
Min. pressure in piston mode (bars)	0
Min. pressure in piston mode (bars)	0
Flow coefficient (%)	80%

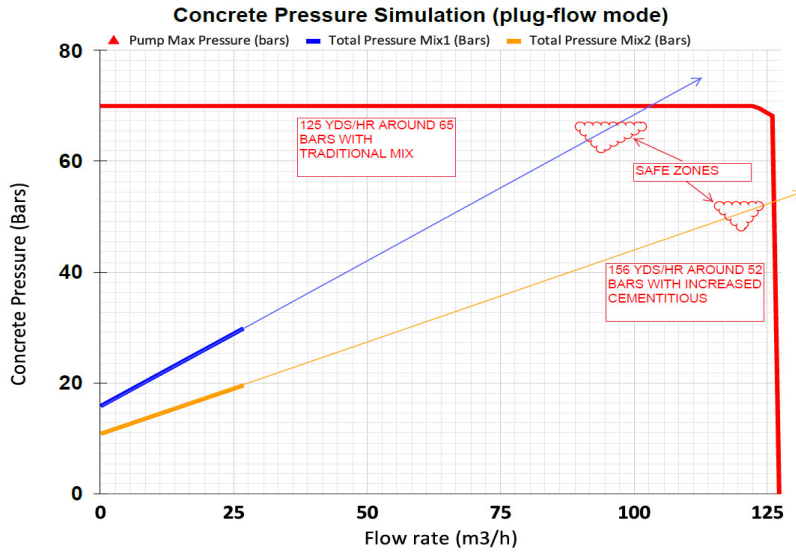
Web based platform for concrete and pump selection

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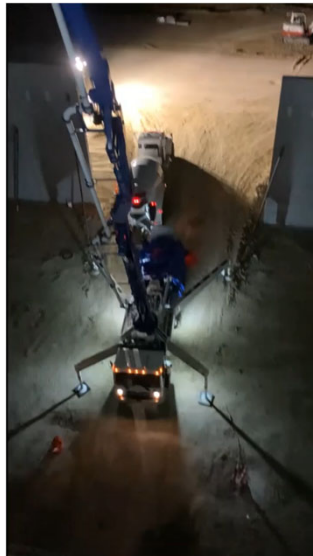
A US FIRST AT A COLORADO DISTRIBUTION CENTER PROJECT

Pumpability results



A US FIRST AT A COLORADO DISTRIBUTION CENTER PROJECT

Using SMARTFLOW Technology to optimize concrete pumpability and CO2



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A US FIRST AT A COLORADO DISTRIBUTION CENTER PROJECT

Initial vs. final mix design

Application: Slab on Metal Deck (pumped)

Structural Macrofibers 7.5 lbs/yd

Fly ash 15%

Volume = 25,000 cy to date

ENGINEER'S PROPOSED MIX

611 lbs cementitious

GWP = 320 kgCO₂eq/m³



FINAL APPROVED MIX AFTER TRIBOMETER STUDY

535 lbs cementitious

GWP = 288 kgCO₂eq/m³ (-10%)

CO₂ savings = 612 t CO₂ eq

77 homes' energy use for one year

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**SMARTCAST-
PIONEERED IN
COLORADO**



CONCRETE STRENGTH PREDICTION TOOL - SMARTCAST

Concrete Strength and Temperature Monitoring Service



- Utilizing current and next generation tech to accurately predict in-situ strength
- Critical when utilizing low carbon mix designs
- Eliminates human error when evaluating mix performance
- Typical segments: High Rise & Infrastructure



Low Carbon Concrete – Denver’s Populus Hotel

Using SMARTCAST Technology to Meet Stringent Construction Schedules

Place:
Denver CO

Building type:
Hotel

Date:
2022-2023

Height:
14 floors

GWP Reduction:
30% Reduction

Volume:
7,875
Approx. CY



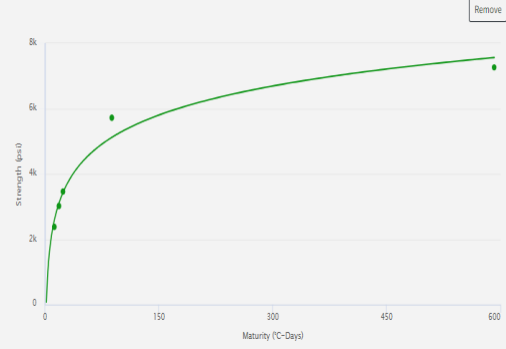
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Low Carbon Concrete – Denver’s Populus Hotel Using SMARTCAST Technology to Meet Stringent Construction Schedules

7609706E 6K ECOPACT

Maturity Function	Nurse-Saul
Datum Temperature	0
Last Verified	13/01/2023 09:06
Verified by	Stephen Herald
Version	1



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Low Carbon Concrete – Denver’s Populus Hotel Using SMARTCAST Technology to Meet Stringent Construction Schedules



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Low Carbon Concrete – Denver’s Populus Hotel Using SMARTCAST Technology to Meet Stringent Construction Schedules

Application: Structural Slabs on Deck (pumped) 6K PSI

Fly ash 33%

Volume = 3,100 cy

TRADITIONAL MIX

750 lbs cementitious

GWP = 422 kgCO₂eq/m³



FINAL APPROVED MIX AFTER MATURITY STUDY

750 lbs cementitious (33% Class F FA)

GWP = 302 kgCO₂eq/m³ (-29%)

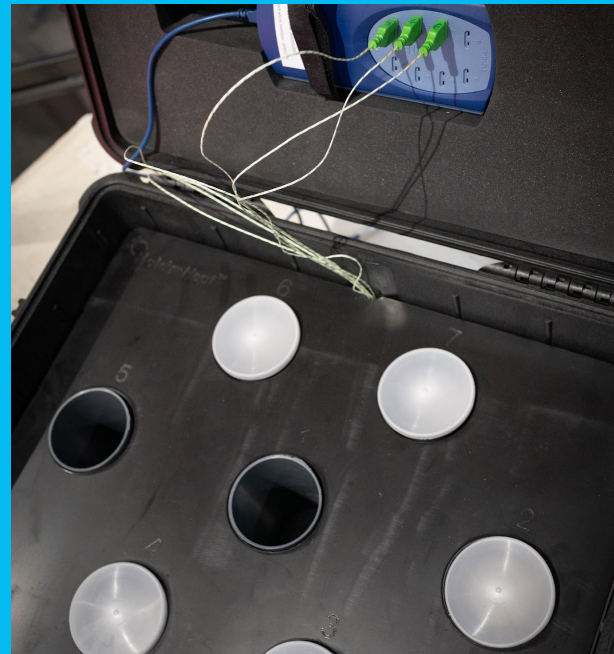
CO₂ savings = 284 t CO₂ eq

36 homes' energy use for one year

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SMARTHERM- THERMAL PREDICTION



SMARTHERM BY HOLCIM – BENEFITS



OPTIMIZE MIX DESIGNS
Finding the best mix to comply with all temperature specifications whilst minimizing costs



REDUCE RISKS
Less problems related to heat of hydration, e.g. crack formation or early freezing



REDUCE COSTS
No waste for potential real-size mockup to test temperatures in mass concrete elements

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SMARTHERM BY HOLCIM – SCOPE OF SERVICE

1



Characterize the binder's heat of hydration

2



Based on the binder's heat of hydration, derive the specific «thermal fingerprint» of the mix

3



Virtual simulation of the temperature development

4



Depending on complexity two-dimensional or three-dimensional assessment can be conducted

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All results are summarized in an easy-to-read, comprehensive report

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STEP 1: CONCRETE MIX DESIGN

The screenshot shows the 'MIX DESIGN' window with the following data:

Ingredient	Mass (kg)	Density (kg/m³)	Volume (l)	Mass per cubic meter (kg/m³)	Thermal Conductivity (W/m·K)	Massic Heat Capacity (J/kg·K)	Temperature (°C)
Portland cement + SCM	360	3050	98	363.9	1.55	790	20
Water	175	1000	175	175.9	0.6	480	20
Ice	0	916.7	0	0	2.3	480	0
Admixture	0	1000	0	0	0.6	480	20
Fine aggregate - Quartz	913	2650	344.5	922.8	3	840	20
Coarse aggregate - Basalt	913	2750	332	922.8	1.9	840	20
Inert mineral addition 1 - Inert fly ash	0	2700	0	0	3.2	840	20
Inert mineral addition 2 - Inert fly ash	0	2700	0	0	3.2	840	20
Air [%]	2	12	19.8	0	0	0	20
Total	2381	2386.4	899.3	2386.4	1.78	894	20

Note: only green cells go to further calculation. All the masses will be normalized per m³.

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STEP 2: MORTAR MIX DESIGN FOR HOLCIM-HEAT TEST

The screenshot shows the 'MIX DESIGN' window with the following data:

Ingredient	Mass (kg)	Density (kg/m³)	Volume (l)	Mass per cubic meter (kg/m³)	Thermal Conductivity (W/m·K)	Massic Heat Capacity (J/kg·K)	Temperature (°C)
Portland cement + SCM	360	3050	98	363.4	1.55	790	20
Water	175	1000	175	259	0.6	480	20
Ice	0	916.7	0	0	2.3	480	0
Admixture	0	1000	0	0	0.6	480	20
Fine aggregate - Quartz	913	2650	344.5	1403.4	3	840	20
Coarse aggregate - Basalt	0	2750	0	0	1.9	840	20
Inert mineral addition 1 - Inert fly ash	0	2700	0	0	3.2	840	20
Inert mineral addition 2 - Inert fly ash	0	2700	0	0	3.2	840	20
Air [%]	2	12	19.8	0	0	0	20
Total	1448	2225.6	650.6	2225.6	1.73	1092	20

Note: only green cells go to further calculation. All the masses will be normalized per m³.

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STEP 3: THERMAL FINGERPRINT IDENTIFICATION

The screenshot shows the 'IDENTIFICATION OF CEMENT FINGERPRINT' software interface. It features a sidebar on the left with navigation options like 'Monitor mix design', 'High Heat', and 'High Early'. The main area contains several input fields for sample information, including 'Date', 'Sample Name', 'Initial Temperature', 'Average Room Temperature', 'Activation Energy', and 'Heat [J/g]'. A graph titled 'Sample temperature' displays a curve of temperature over time, with a peak around 15 minutes. Below the graph, there is a section for 'Compute thermal cement fingerprint' with fields for 'Activation energy [J/mol]', 'Maximum heat release [J/g]', 'Ultimate hydration degree', 'Cement name', 'Cement description', and 'Cement phase'. Buttons for 'Download report' and 'Save to cement database' are visible at the bottom right.

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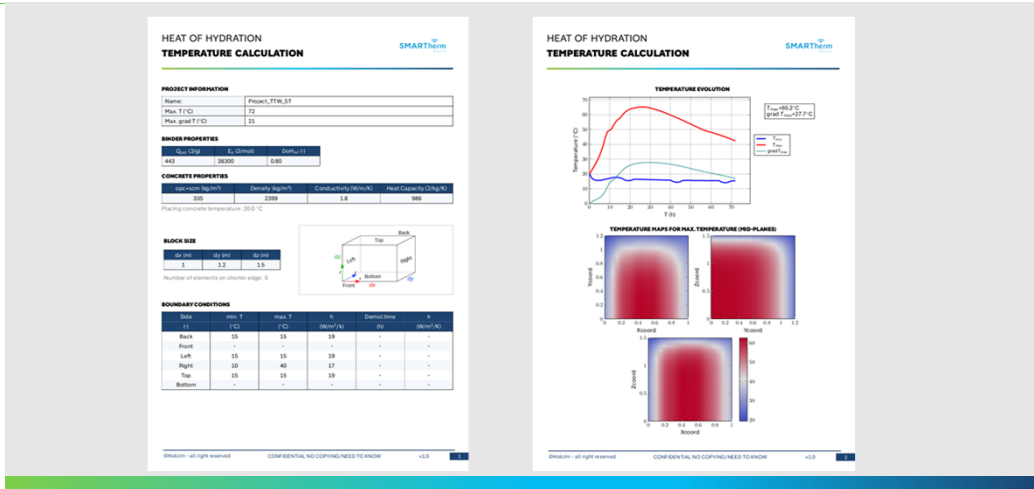
STEP 4: THERMAL PREDICTION

The screenshot shows the 'HEATING BLOCK TEMPERATURE' software interface. It features a 3D diagram of a block with dimensions 'dx', 'dy', and 'dz'. The interface includes input fields for 'Initial temperature [C]', 'Integration time step [s]', 'Target time [s]', 'Time of casting', and 'Sensors on adjacent edges'. There are sections for 'Concrete & Cement' and 'Sensor' with various input fields and a table for defining sensor locations and conditions. The table has columns for 'Condition type', 'Max. T [C]', 'Min. T [C]', 'x [meter]', 'y [meter]', 'z [meter]', 'dx [meter]', 'dy [meter]', 'dz [meter]', and 'Sensor'. The table contains three rows of data for different sensor locations. Buttons for 'Save' and 'Calculate temperature' are visible at the bottom right.

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STEP 4: THERMAL PREDICTION



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<https://www.holcim.us/concrete>