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SmartRock™

Revolutionizing the Construction Industry

Presenters

Matthew Denton

Channel Manager

ASIA + EMEA

- Started in concrete in 2002
- International experience with leading formwork company
- South African Distributor for Giatec since 2016
- Joined Giatec in 2019

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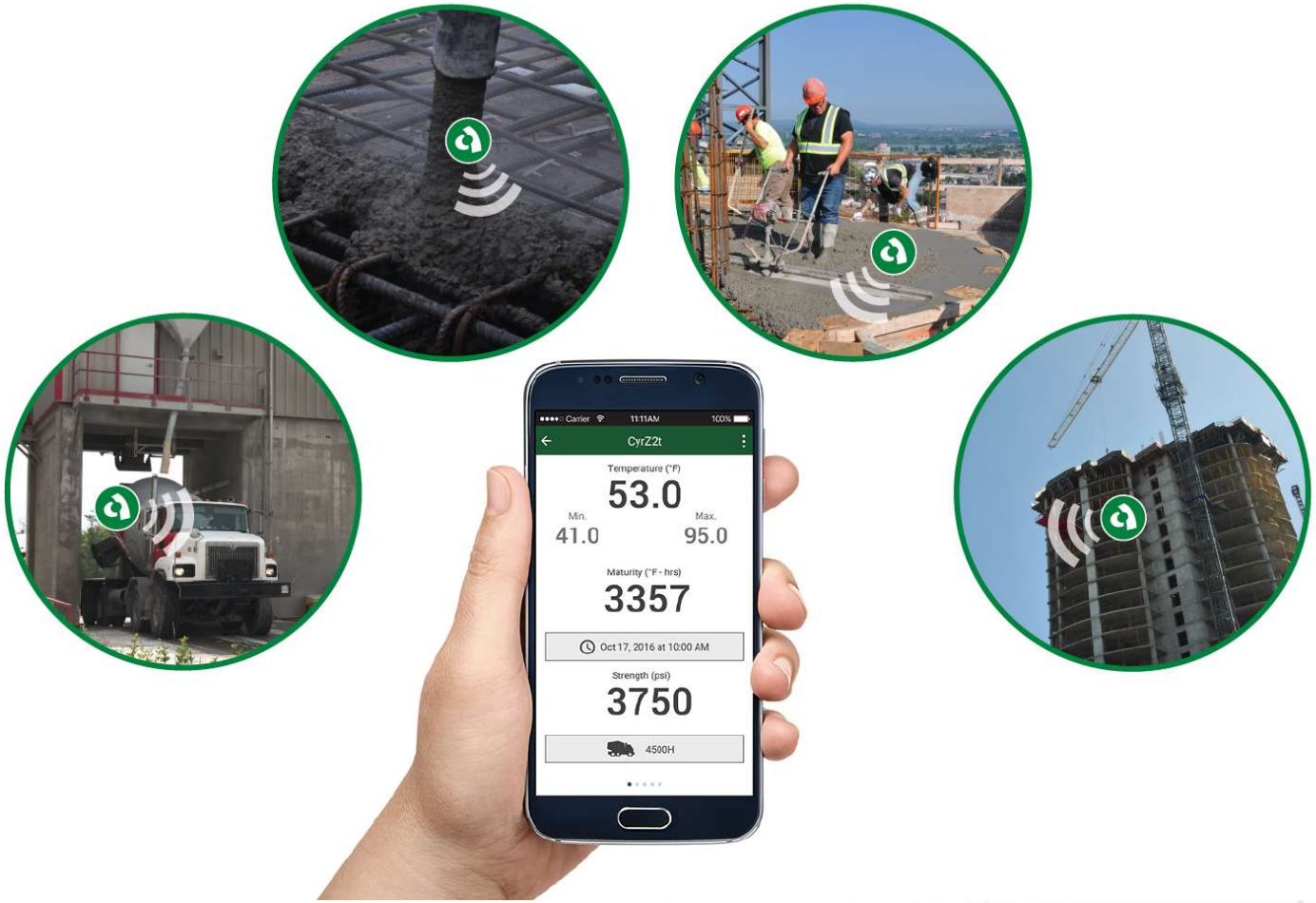
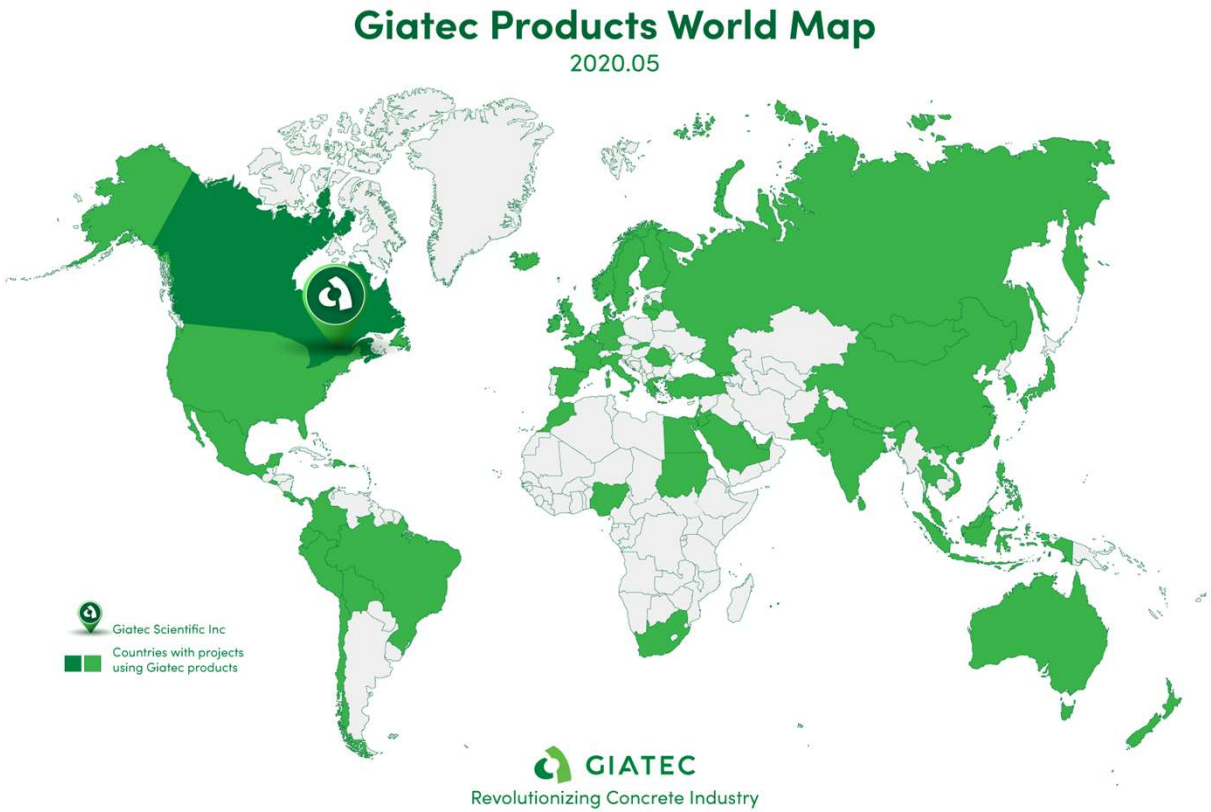
MY CONCRETE IS
SMART™

Vision: Revolutionizing the Construction Industry



World presence



Your Dealer in HK-Macau: GEAR-UP MATERIALS LTD.

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Director

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  Lai Chi Kok, Hong Kong

GEAR-UP MATERIALS

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CIC – Maturity Methodology Guidelines

- Project owner: **HK Construction Industry Council**
- 項目所有者：**香港建造業議會**
- Researcher: **ARUP**
- 研究機構：**奧雅納**
- Subject: ***Application of Maturity Method for Determination of Early Age Concrete Strength***
- 主題：***基於成熟度預測混凝土強度在香港建造業中的應用***
- Source: http://www.cic.hk/eng/main/research_data_analytics_/cic_fund_projects/cop/
- Date: **December 2020**
- **日期：2020 年 12 月**

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Hong Kong CIC: CITF pre-approved list
香港建造業議會：CITF預先核准名單

- Name of the Technology: **SMARTROCK**
- Type of Technology: **Internet of Things (IoT)**
- Product type: **Concrete strength maturity sensor**
- Distribution channel: **Gear Up Materials Limited (Sole Authorized Dealer in HK-Macau)**
- Code: **PA20-013**

- 技術名稱：SMARTROCK
- 技術類型：物聯網 (IoT)
- 產品類型：混凝土強度成熟度傳感器
- 分銷渠道：Gear Up Materials Limited（港澳獨家授權經銷商）
- 代碼：PA20-013

CITF 建造業創科基金
CITF Pre-approved Product

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Agenda

1. What is concrete maturity and what are the benefits?
2. Artificial intelligence in concrete
3. The Giatec Solution

What Is Concrete Maturity and What Are the Benefits?

Challenge: How to Measure Concrete Strength?

Field-cured specimens

Does not represent the actual concrete in-situ (smaller volume and different temperature)

Lab-cured specimens

Does not represent neither the curing condition nor the in-situ concrete

Maturity meters

Measures the real temperature and strength in the concrete element

Limitations of Concrete Cubes/Cylinders

1. Accurate temperature conditions
2. Delayed results
3. Limited information
4. Local Variations
5. Low visibility

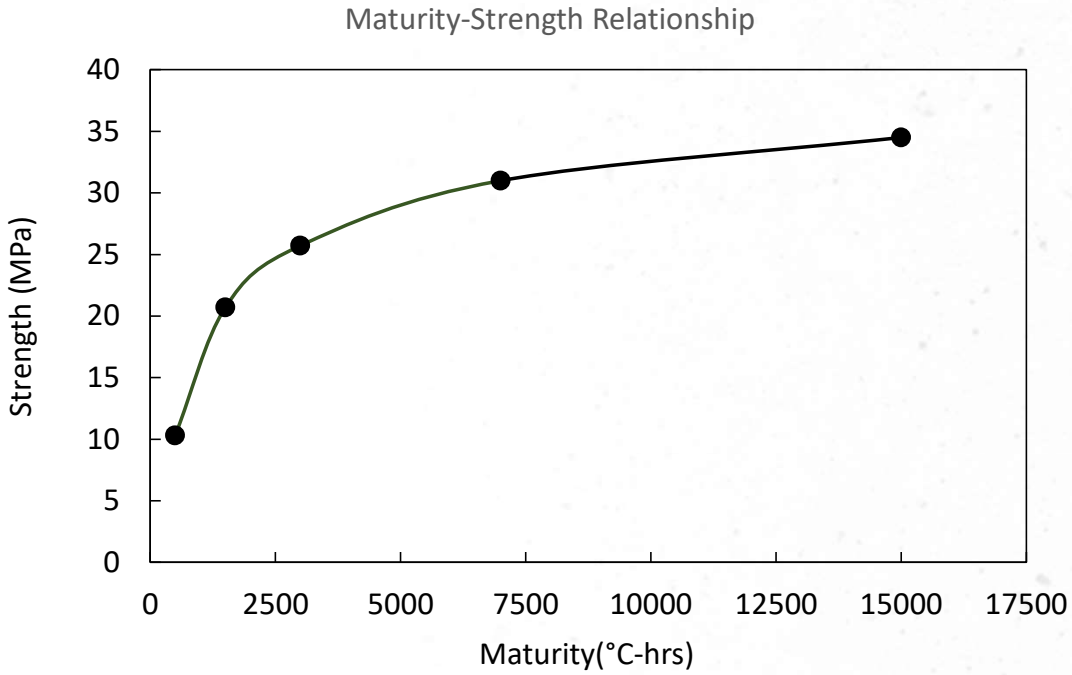
What is Maturity?

A non-destructive method to estimate the **real-time strength** development of in-place concrete, specifically at **early ages** less than 14 days.

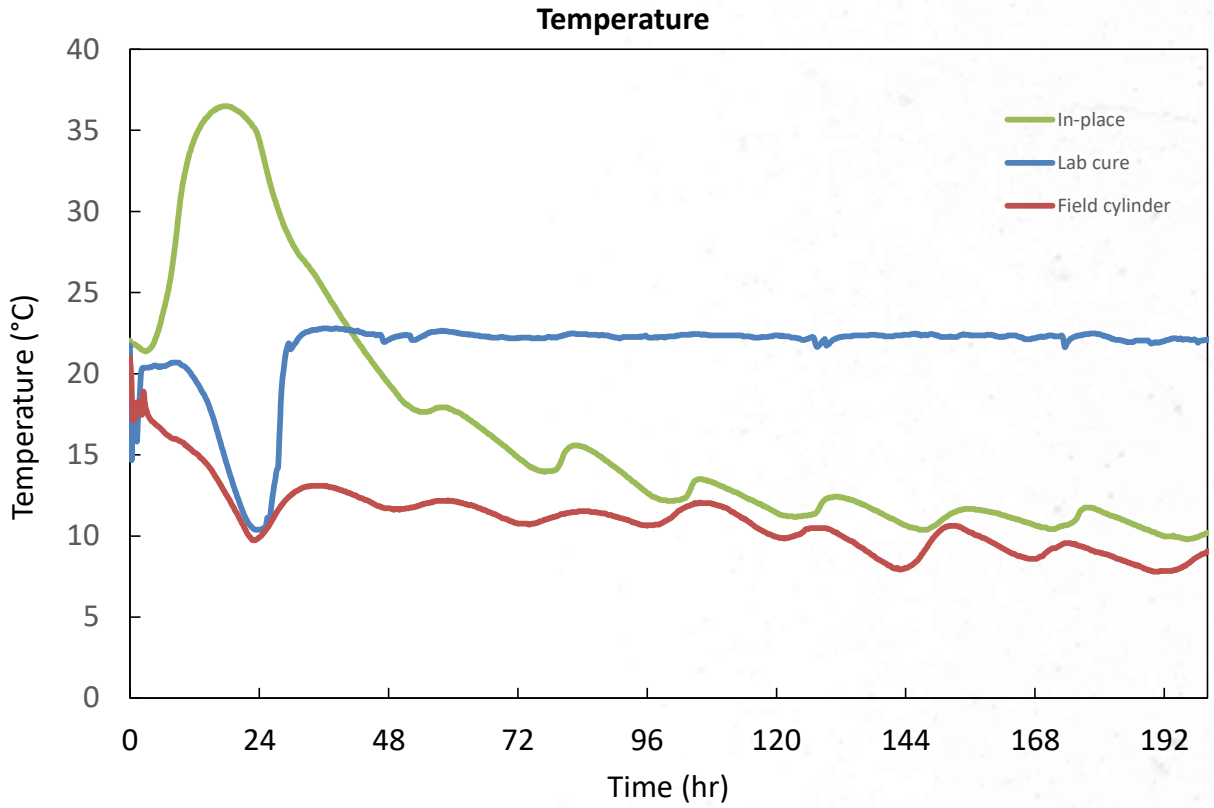
It uses the **temperature history** of concrete during curing to estimate strength development. The maturity method requires a **calibration** prior to use in order to correlate the maturity to strength. Maturity **calibration is specific for a mix design**.

What is Maturity?

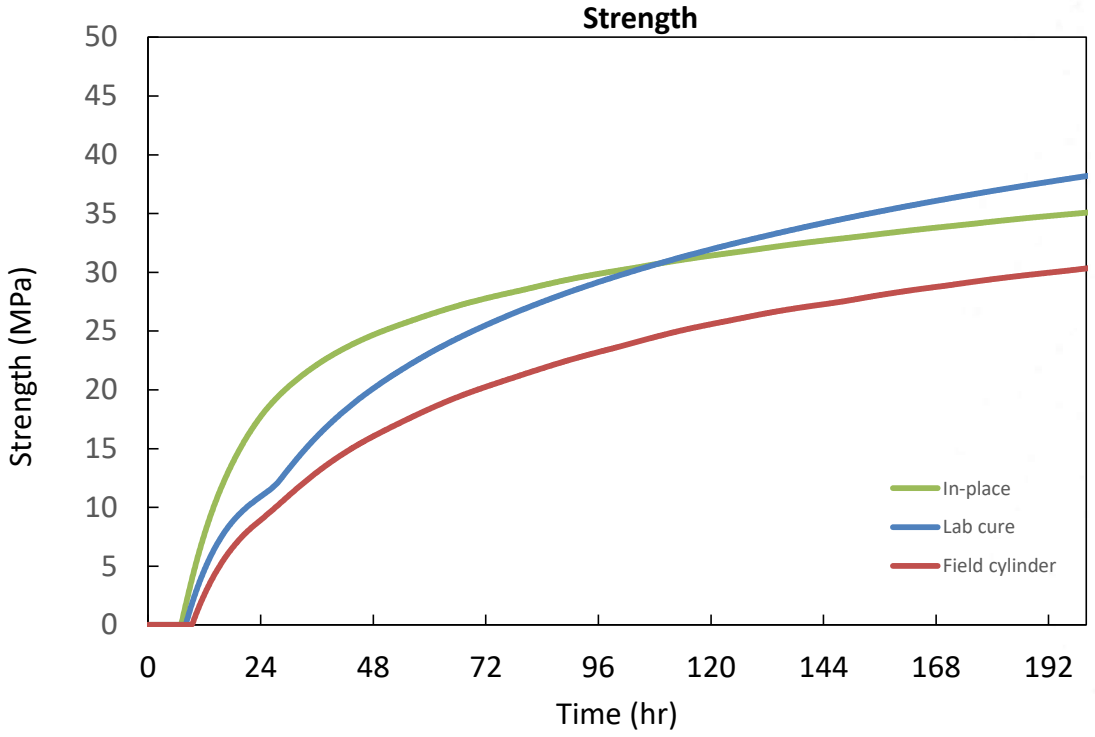
- A unique relationship between the Maturity Index (a function of concrete temperature) and Concrete Strength for each concrete mixture



Lab-Cured vs. Field-Cured vs. In-Place Strength



Lab-Cured vs. Field-Cured vs. In-Place Strength



Time	**In-place** concrete strength (MPa)	**Lab- cured** cylinder strength (MPa)	**Field** cylinder strength (MPa)
24hr (1day)	**17.5**	10.8	**8.8**
72hr (3days)	**27.7**	25.4	**20.2**
168 hr (7 days)	33.8	**36.1**	**28.8**

Applications for Concrete Maturity

- Formwork removal
- Post-tensioning
- Opening traffic on concrete pavement
- Mass concrete
- Simultaneous temperature measurement
- Heat curing optimization
- Saw cutting
- Precast
- Slab, walls, columns, beams, foundations, roads, dams, tunnels, tilt up, shotcrete

The Giatec Solution

SmartRock3™ Sensor

Logger/transmitter: Battery, Bluetooth antenna, memory and secondary temperature sensor

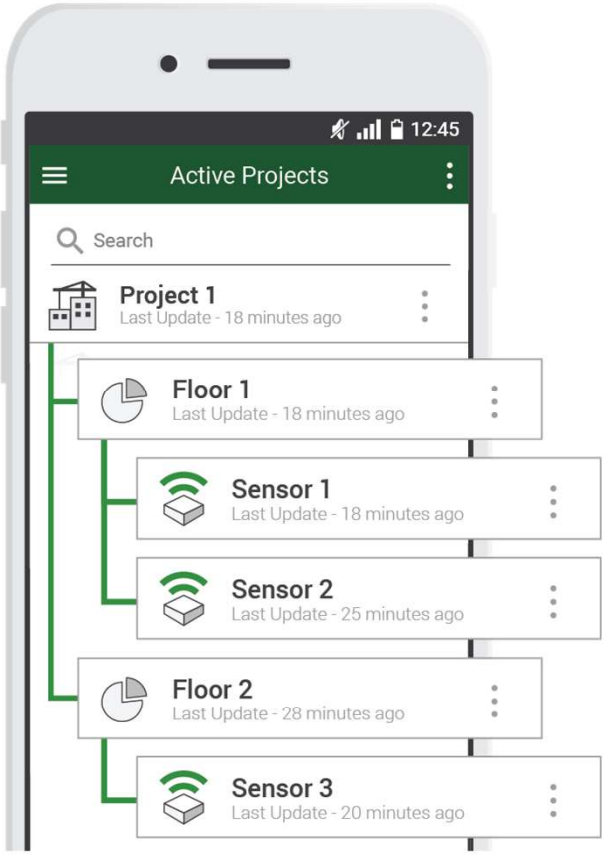
QR Code: Scan QR code to tag the sensor

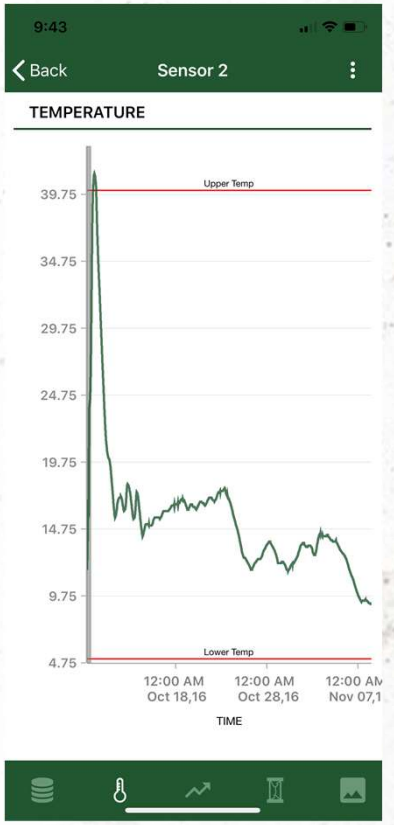
Temperature Cable: NTC

Activation channel: Pull out probe to activate sensor

Installation strap: To secure sensor to reinforcement

Mobile Application





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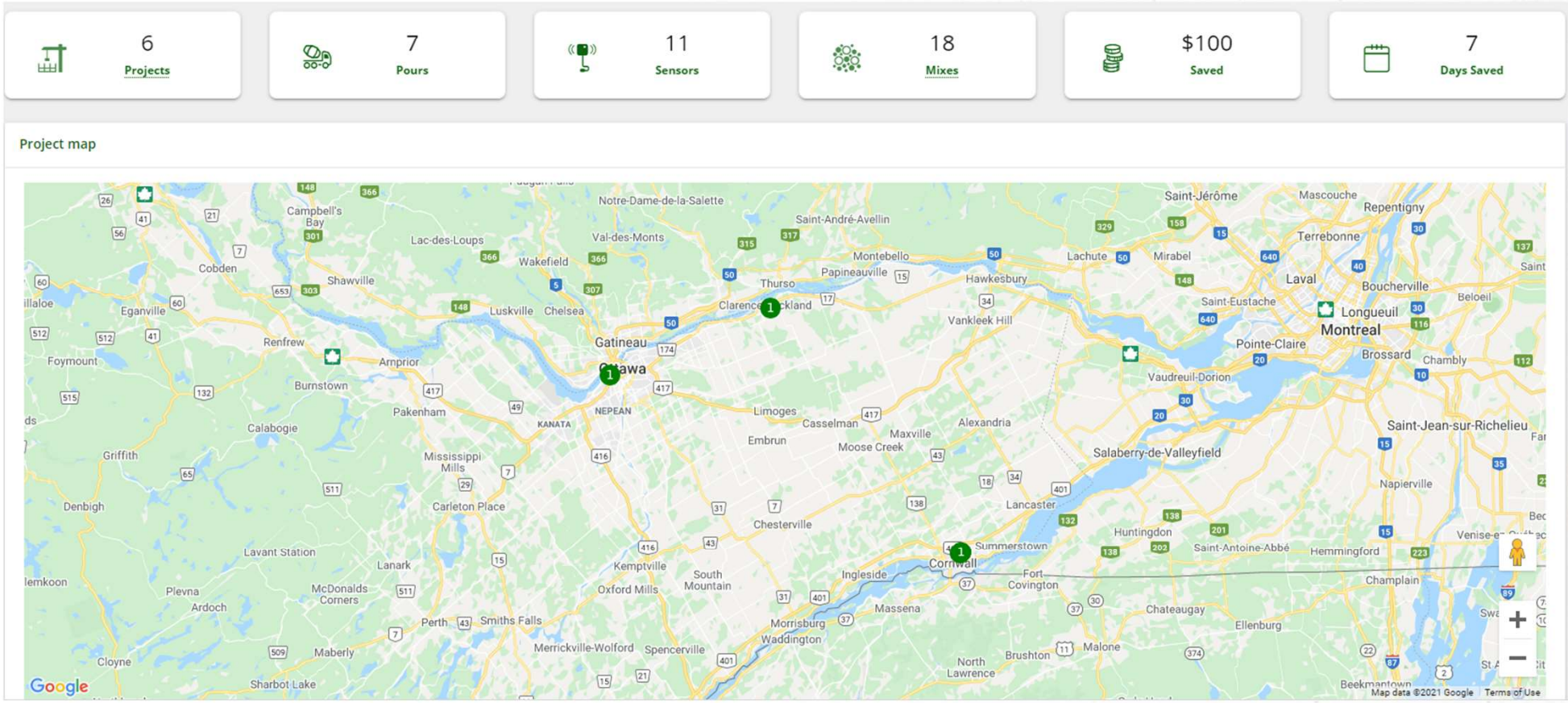
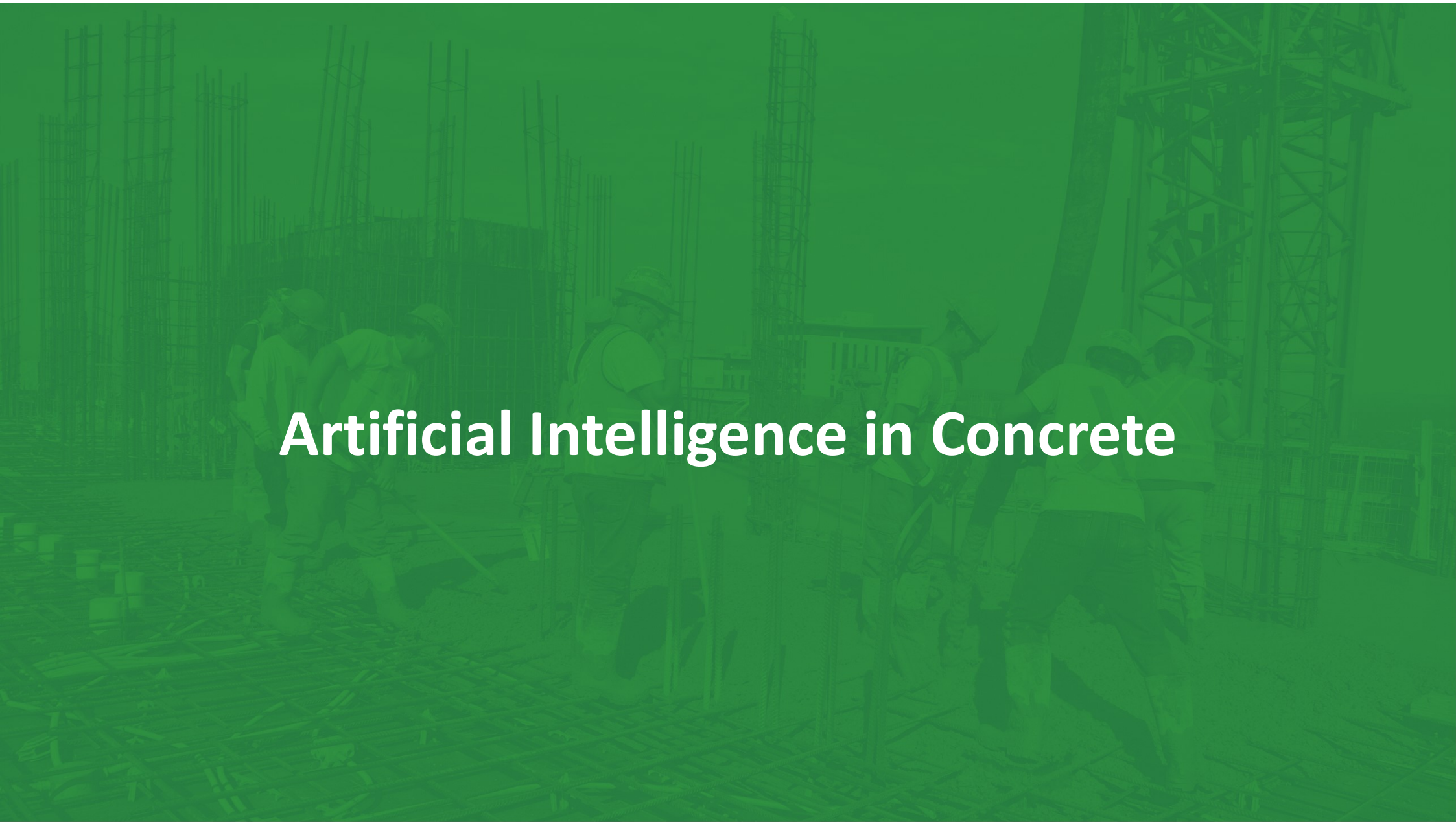
Giatec 360 Software



SmartHub Solution

- Without the need to go to the jobsite, users can track the temperature and strength from anywhere, at anytime

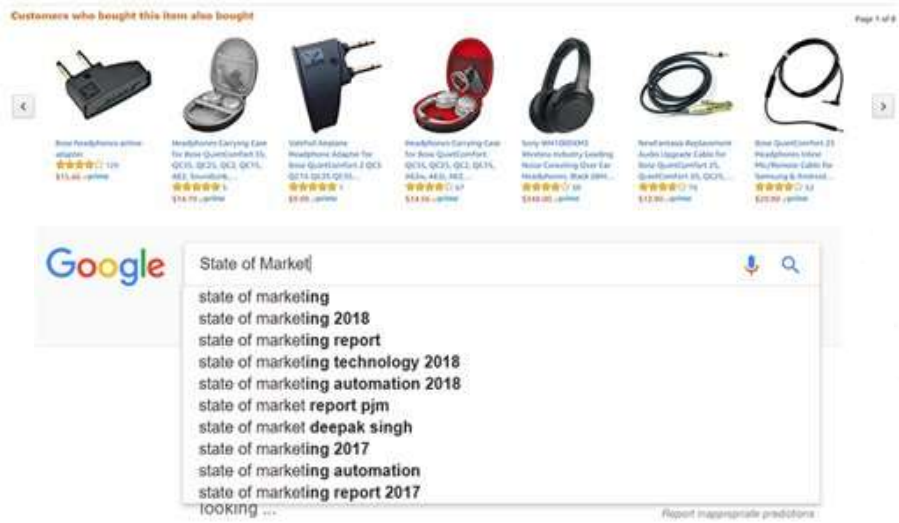
  - Real-time data display
  - Wire-free and wireless technology
  - Rugged and wireless design
  - Android tablet
  - Long battery life
  - Easy installation and activation
  - Battery charger



Artificial Intelligence in Concrete

What is Artificial Intelligence (AI)

The science of providing computer systems the ability to automatically learn and improve from experience without being explicitly programmed



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Roxi: Who is she?

The first AI program created for concrete testing.

Roxi has been trained for :

1. Concrete pouring time
2. Mix validation
3. Cement reduction

She is still learning !

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Roxi: AI for Pouring time

Output: Suggests pouring time based on temperature history in your concrete

How: Trained on thousands of temperature curves in concrete and identified the pouring time

Advantages:

- Sets the pouring time on your sensor if you forgot
- Sets accurate pouring time for different sensors in the same pour
- If some changed the pouring time Roxi will be able to notice and provide adjustments
- Insures that the calculations are based on the right start time

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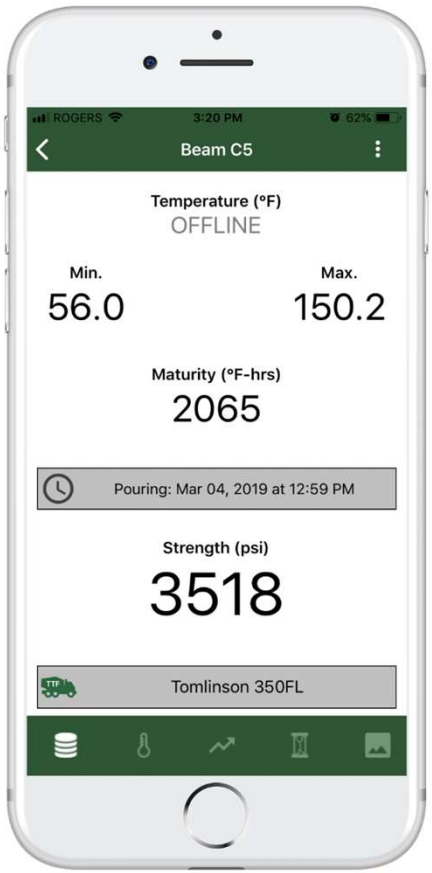
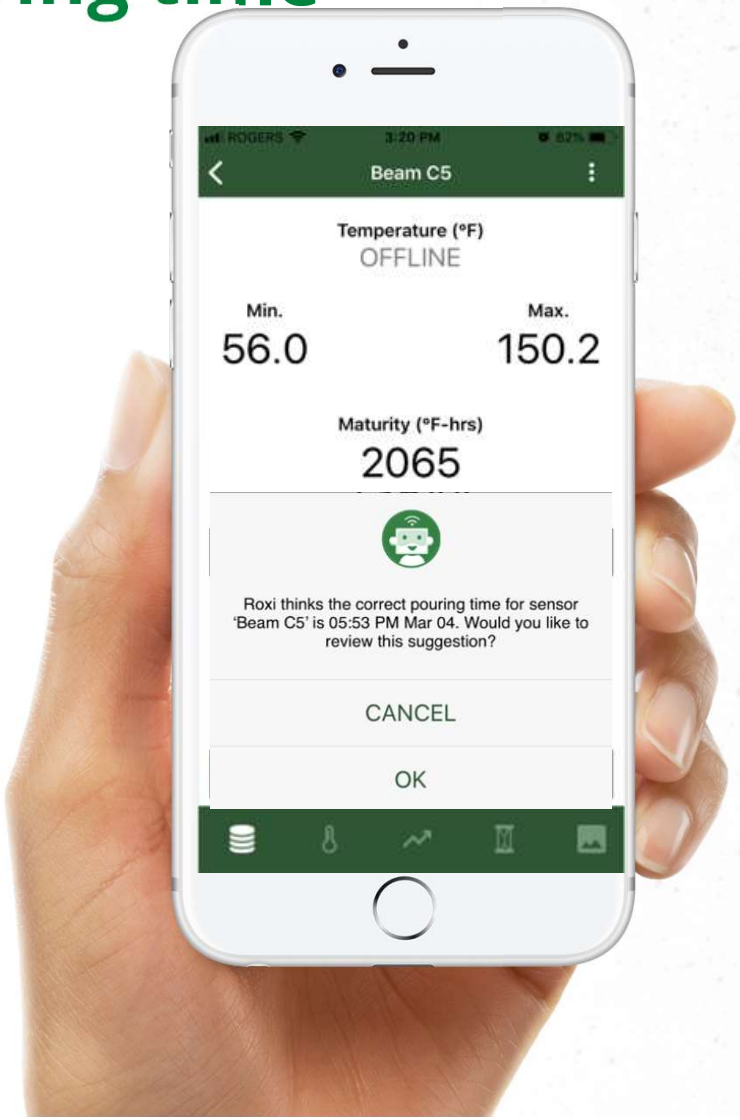
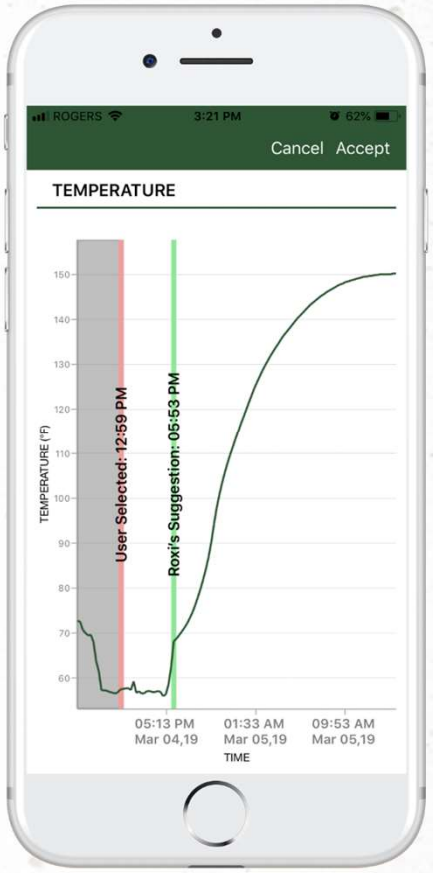
Roxi: AI for Pouring time







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Roxi: AI for Mix Validation

First unique AI to evaluate mix-design in the world

Output: Validate if your maturity calibration is right for your mix design

How: Trained on thousands of mix designs and break results collected over multiple years

Advantages:

- Uncovers human error on maturity calibrations
- Detects errors based on mix proportions
- Suggests improvements based on maturity points

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Roxi: AI for Mix Validation

1. Mix Information
2. Mix Calibration
3. Mix Proportions

Maturity(°C-hrs)	Strength(MPa)
750.53	11.72
1297.14	22.75
1839.18	27.58
3832.96	39.99
7644.91	49.64

	Ingredient		Quantity		Description
–	Cement	type I/II	320.4747774480712	kg/m³	
–	Water		178.04154302670622	kg/m³	
–	Fine aggregate		1000	kg/m³	
–	Coarse aggregate		1186.9436201780416	kg/m³	
–	Fly ash		94.9554896142433 2	kg/m³	
–	High range water reducer		148.32	ml/m³	
+					

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Roxi: AI for Mix Validation

Example of output:

Your mix is looking good. Roxi found 0 issues with your mix

Roxi found 1 possible issues with your calibration

- The entered strength values seem to be high for the entered mixture proportions.

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Roxi: AI for Cement Reduction

Output: Proposes cement reduction based on mix performance

Advantages:

- Understand how you can reduce your CO_2 consumption on your project
- Optimizes your concrete performance
- Reduce your mix cost

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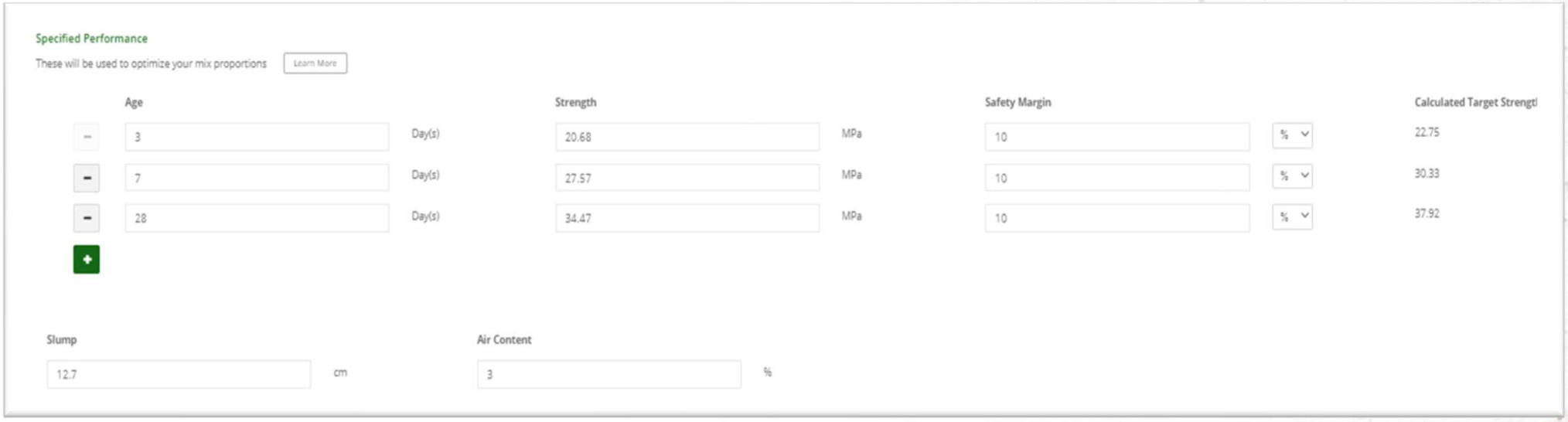
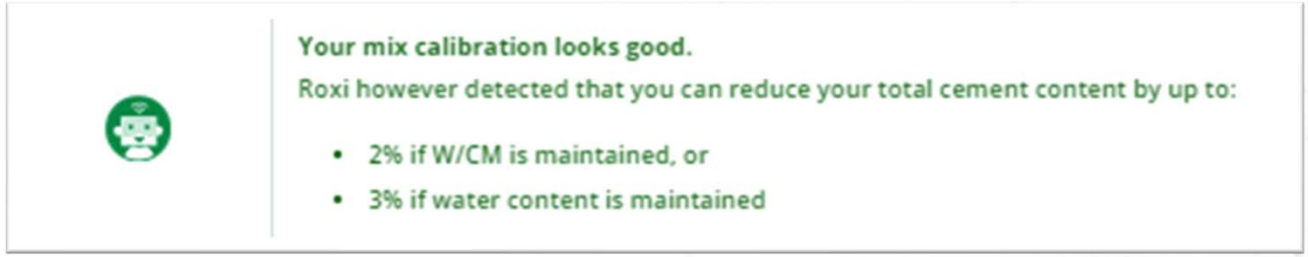
Roxi: AI for Cement Reduction





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Cement saving – PT Deck Example

- Design strength: 40 MPa / Target strength: 20 MPa

Mix 1	
Mix proportions	
Cement (kg/m^3)	355
Water (kg/m^3)	150
w/c	0.42
3 days target strength	20 MPa
3 days sensors	25 MPa
Difference	5 MPa
Overperforming	

Possible cement reduction from AI suggestion:

4% cement reduction, keep water content (workability)

Mix 2	
Mix proportions	
Cement (kg/m^3)	341
Water (kg/m^3)	150
w/c	0.44
3 days sensors	**22 MPa**
Good performance	

CO2 Emission Reduction	
Mix 1	355 kg
Mix 2	341 kg
Difference	14 kg
In 350 m^3 of concrete	**4,900 kg**
Approximate CO_2 savings	**3,900 kg**

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Cement saving – Entire project

Project Example				
Number of storeys	Pours per Storey	Pour Volume	Total Volume	Total CO_2 reduction
15	2	350 m^3	10,500 m^3	**100,000 kg**

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Project References in Hong Kong and International
項目參考

Project references in Hong Kong

Project Name/Contract No.	Location	Contractor	Structures
Contract No. HY/2014/20 - Central Kowloon Route – Yau Ma Tei West	Yau Ma Tei West	Build King-SK E&C JV	Pile caps, piers, capping beams, noise barriers
Contract No. HY/2018/02 - Central Kowloon Route – Kai Tak East	Kai Tak East	Alchmex-Paul Y JV	Slabs and beams
Contract No. HY/2014/07 - Central Kowloon Route – Kai Tak West	Kai Tak West	Gammon Construction	Underpass roof slab
Contract No. ED/2018/04 - Trunk Road T2 and Infrastructure Works	Kowloon Bay	Bouygues TP (Dragages HK)	Tunnel Lining and strutting slabs
Contract No. SSH508 (NEC3 ECC Option B) (For Phase 2 Works) – Kai Tak Square	Kai Tak Square	Aggressive Construction	Roof of Step Terrace-6
Contract No. DC/2018/06 – Shek Wu Hui Effluent Polishing Plant – Main Works Stage 1	Shek Wu Hui	Kwan Lee-Chun Wo JV	Slabs and beams, Membrane facilities building
CEDD Kwu Tung North New Development Area	Kwu Tung	Build King	Slabs and beams

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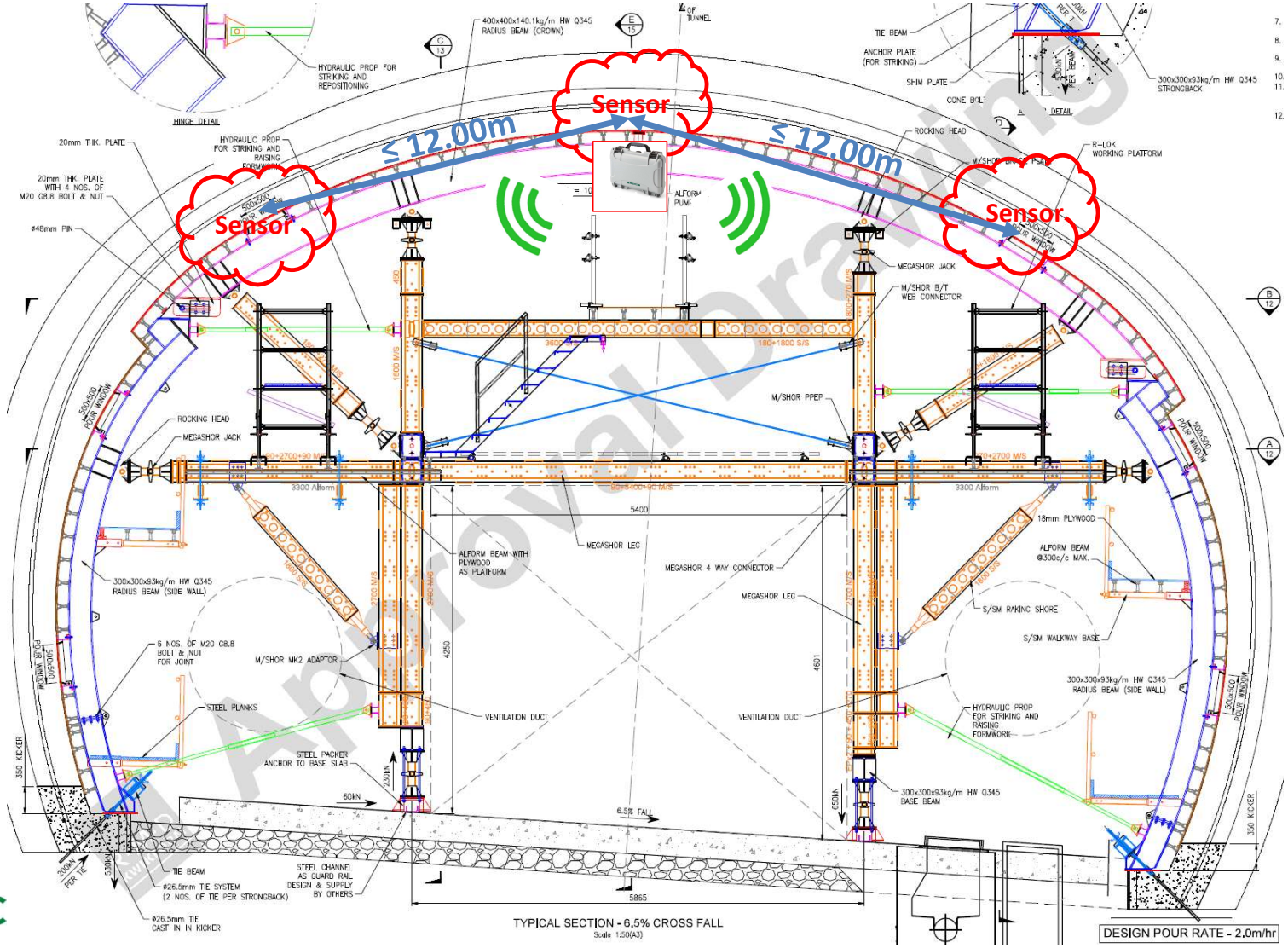
CEDD - Trunk Road T2



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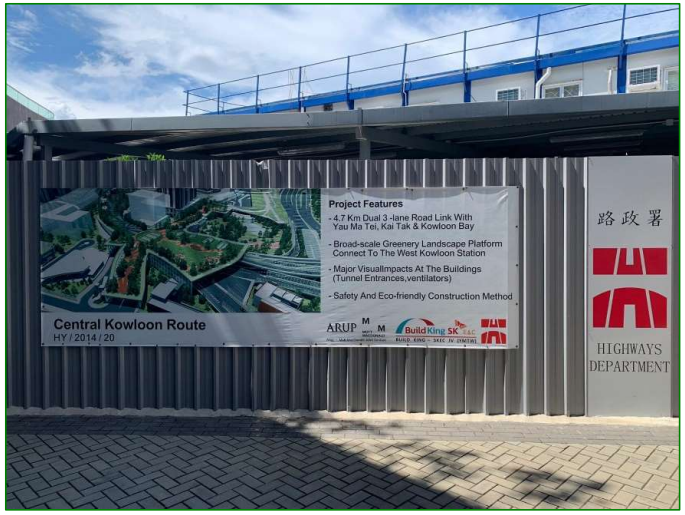
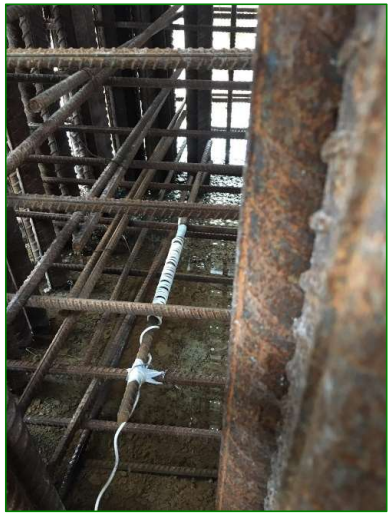
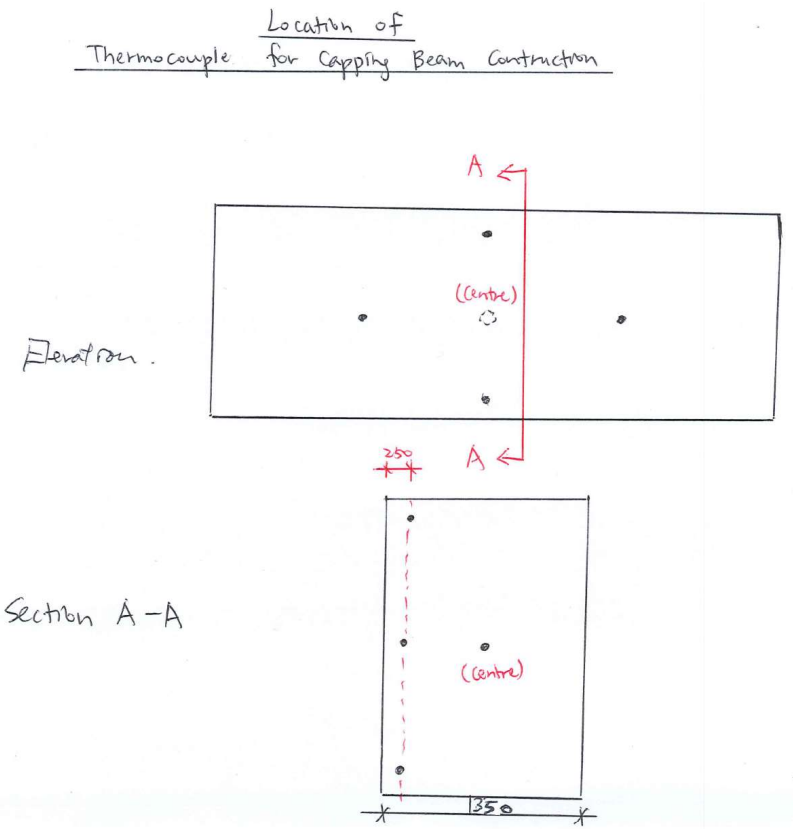
HYD - CKR - Yau Ma Tei West







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HYD - CKR - Kai Tak West

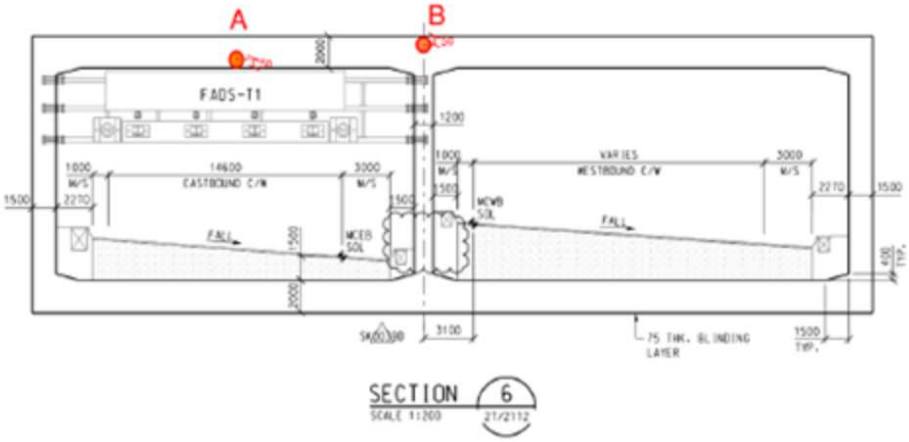
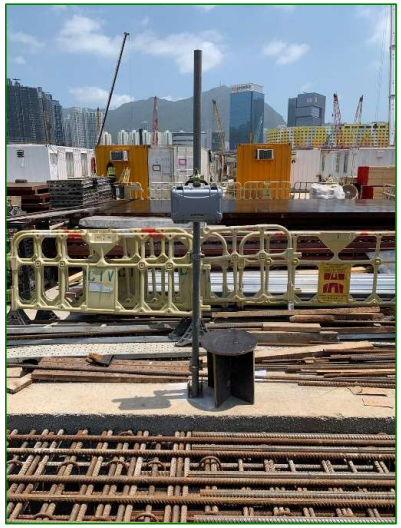


Figure 3 Indicative location of temperature sensors in region A and B. Depth of cover concrete to temperature reading devices is 50 mm.



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HYD - CKR - Kai Tak East

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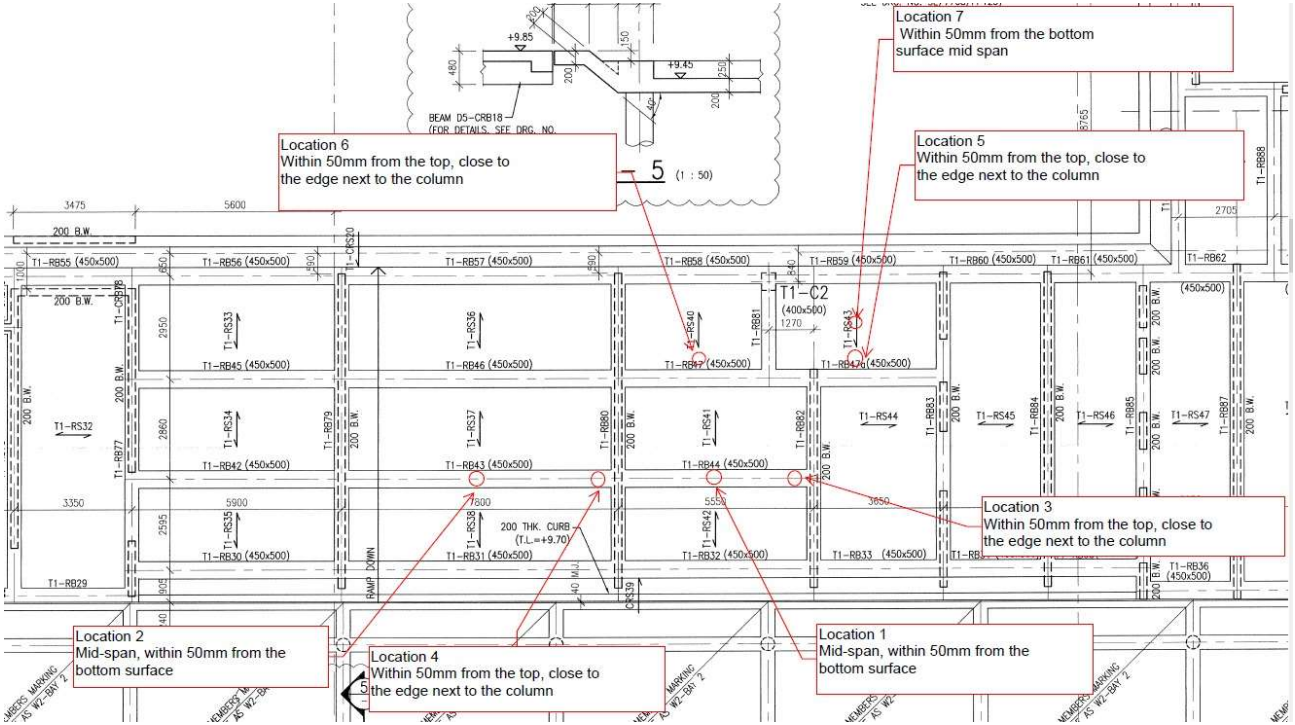
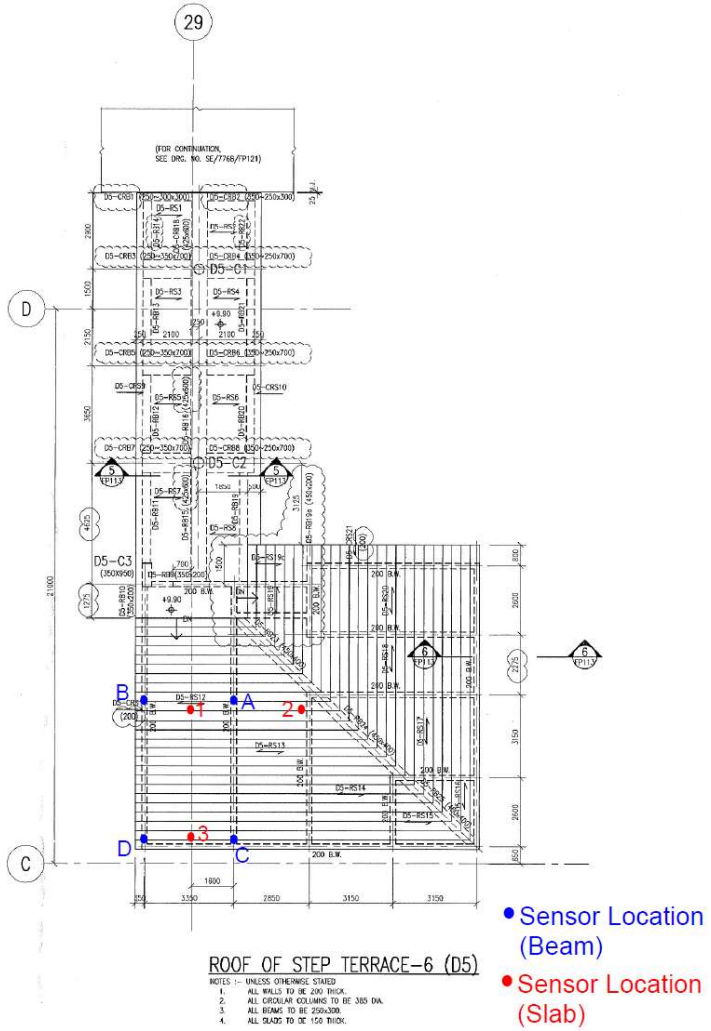
ArchSD - Kai Tak Terrace Step 6





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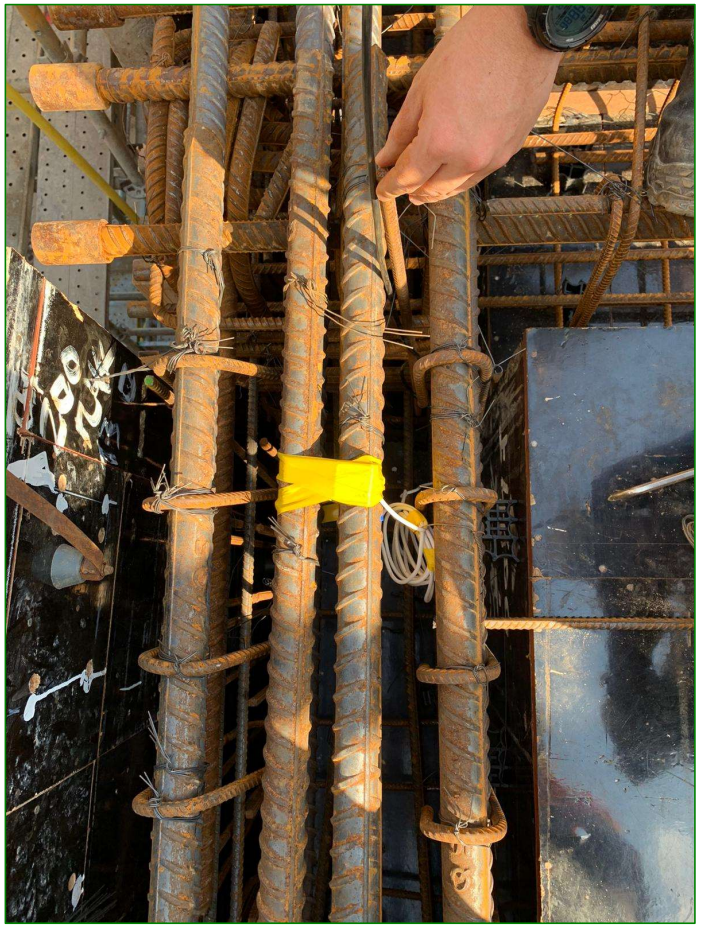
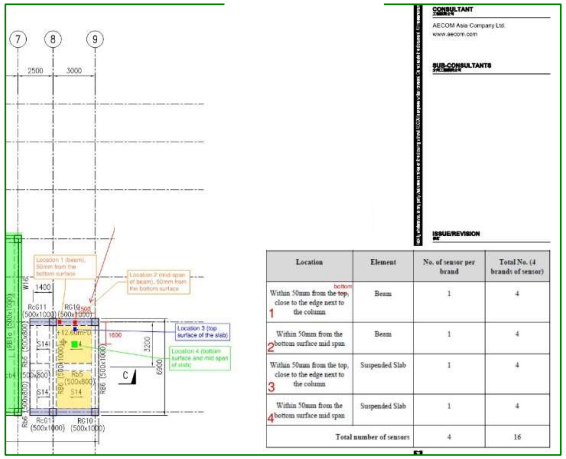
DSD – Shek Wu Hui Plant





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Example – Wind farm South Africa (Concor Construction)

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Example – Wind farm South Africa (Concor Construction)

Roggeveld & Perdekraal Wind farm

Base for each turbine is 19m diameter and about 2.35m high

Extreme heat significantly increases evaporation of water used to hydrate and cure concrete

Sensors used for continuous temperature monitoring of in-place concrete (cannot exceed 70°C.)

Sensors placed below the concrete surface to measure the coldest temperature (gradient differential of less than 20°C over 1 lineal meter required)

Team able to backfill when sensors showed 70% concrete strength resulting in **1 month saved** by relying on SmartRock's strength data for backfilling

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示例 – 南非風電場（Concor Construction）

Roggeveld & Perdekraal 風電場

- 每個渦輪機的底座直徑為 19m，高約 2.35m
極端高溫會顯著增加用於水化和固化混凝土的水的蒸發

傳感器用於連續監測現澆混凝土溫度（不能超過 70˚C。）

傳感器放置在混凝土表面下方以測量最冷溫度（要求在 1 個直線米上的梯度差小於 20˚C）

團隊能夠在傳感器顯示 70% 的混凝土強度時回填，依靠 SmartRock 的回填強度數據節省了 1 個月的時間

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Example – McCormick Hotel

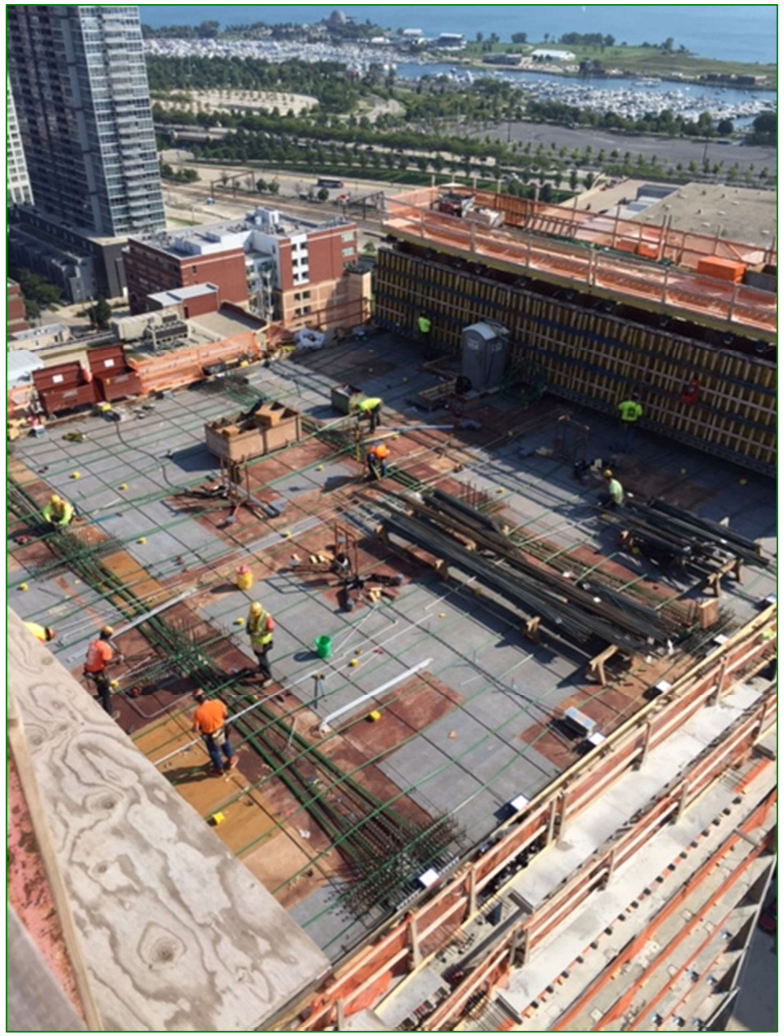

Photo Courtesy of Walt Flood IV

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Example – McCormick Hotel

McCormick Hotel

41 story post-tensioned concrete floor plate, 3-day pour cycle, two 11,000 sf placements per floor

- Using 3 sensors per deck placement

  Contractor and/or Technician check first thing next morning

  Saved 1 day on cycling per placement, **over 10 weeks total saved** during the project

示例 – 麥考密克酒店

麥考密克酒店

- 41 層後張混凝土樓板，3 天澆築週期，每層兩個 11,000 平方英尺的佈置
- 每個甲板放置使用 3 個傳感器
- 承包商和/或技術人員第二天早上檢查第一件事
- 每次放置節省了 1 天的循環時間，項目期間總共節省了 10 週以上

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Example - 1571 Maple Avenue

1571 Maple Avenue

13 story residential
with concrete core
2 separate cores
on the critical path
Using 2 sensors
per core placement

Shortened form cycle from 7-10 days to 4 days

Photo Courtesy of Walt Flood IV

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示例 - 楓樹大道 1571 號

楓樹大道1571號

- 13層混凝土核心住宅
- 關鍵路徑上的 2 個獨立內核
- 每個核心放置使用 2 個傳感器
- 表單週期從 7-10 天縮短至 4 天

Photo Courtesy of Walt Flood IV

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Example – Concrete Pavement, Highway 417

Photo Courtesy of Ryan Andre

- Jobsite 100 km from the testing lab
- Open road to traffic **2 days earlier**

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示例 – 混凝土路面，417 號高速公路

Photo Courtesy of Ryan Andre

- 距測試實驗室 100 公里的工地
- 提前2天通車

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Example - Producer “A”: High Early Mixes

By Walter Siegmund (talk) - Own work, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=3413546
Courtesy Angelle Materials

- 4000 psi @ 48 Hours (instead of 3000 psi)
- Paving & Industrial
- Smart Concrete
- Saved More Than **½ Sack of Cement per Cubic Yd**

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示例 - 製作人“A”：早期高強度混合

- 4000 psi @ 48 小時（而不是 3000 psi）
- 鋪路與工業
- 智能混凝土
- 每立方碼節省了超過 ½ 袋水泥

By Walter Siegmund (talk) - Own work, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=3413546
Courtesy Angelle Materials

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