Placing Digits Before Placing Concrete

How a concrete contractor leverages the latest VDC technologies

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ACI Fall Convention

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Virtual Construction Manager

The Conco Companies

Background

Experience

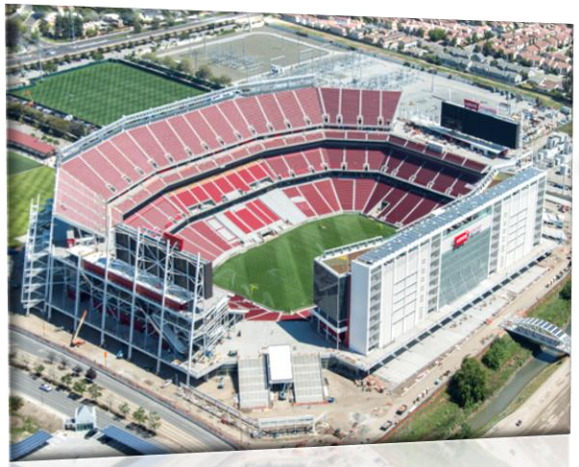
- Construction staking – Robotic Total Station (RTS) Layout
- 3D Laser scanning
- 4D Planning and Scheduling
- Field Technology
- Model-based Estimating
- BIM Coordination

ACI Committee

- ACI 131 Building Information Modeling of Concrete Structures - Voting Member
- ACI 117 Tolerance – Associate Member
- ACI 1170L Laser Scanning – Subcommittee Chair

Background

Salesforce Tower, San Francisco, CA

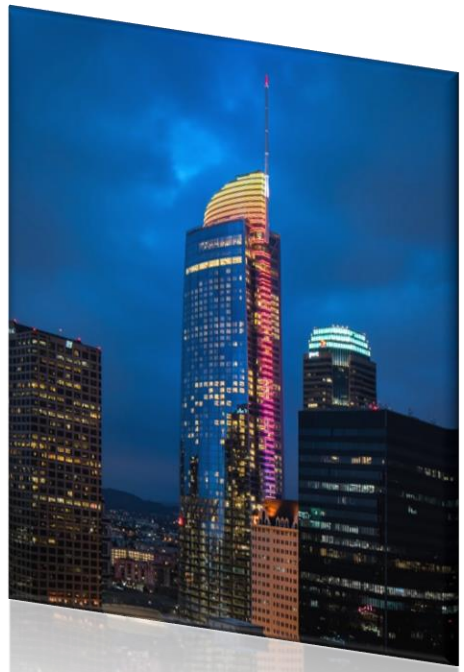


Levi's Stadium, Santa Clara, CA

Conco, founded in 1959, is a one-stop-shop commercial concrete company with headquarters in the San Francisco Bay Area.

- Northern California
- Southern California
- Washington
- Oregon

- Design-Build
- BIM/VDC
- Reinforcing Steel
- Formwork
- Pumping
- Finishing
- Shotcrete
- Confoam



Wilshire Grand Tower, Los Angeles, CA

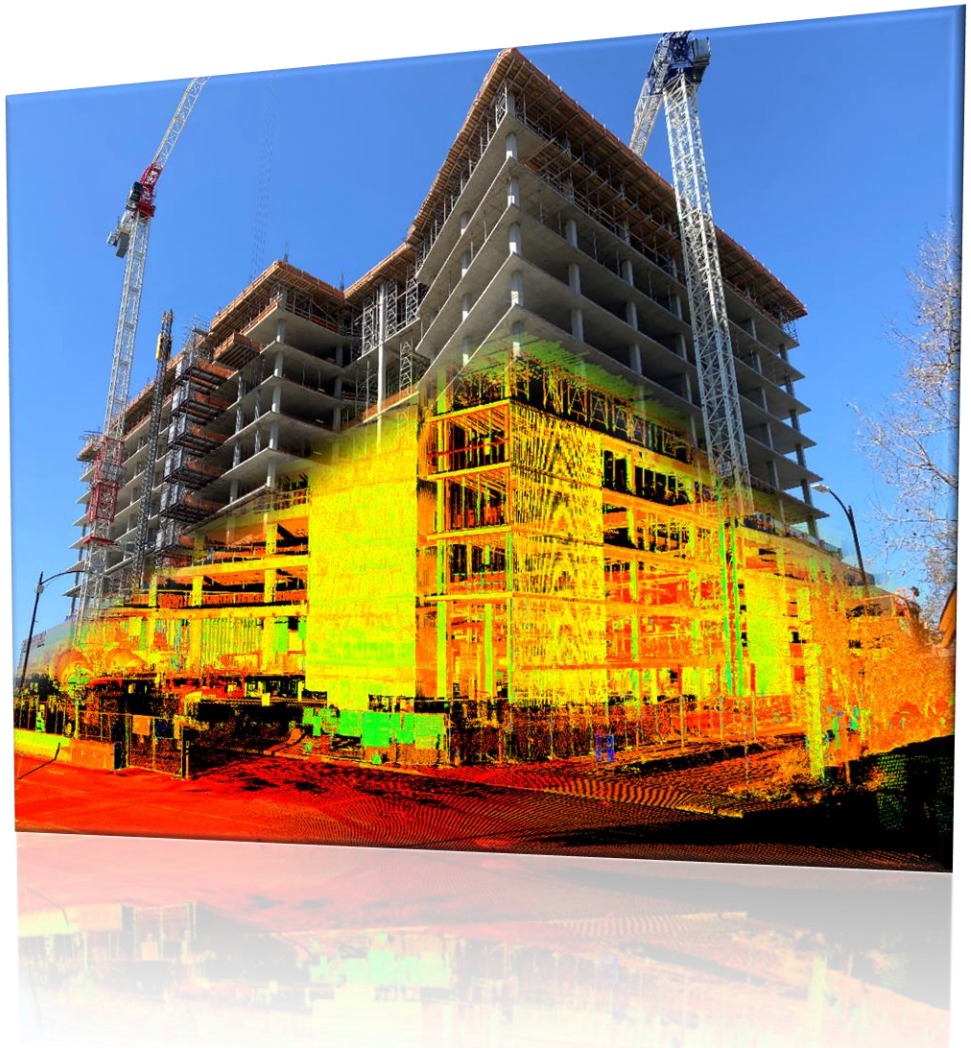
Apple Campus 2, Cupertino, CA

815 Pine St, Seattle, WA

The Grand, Los Angeles, CA

Agenda

- Robotic Total Station Layout
- 3D Laser Scanning
  - Lagging wall scan
  - Safety
  - Prepour scan
  - Postpour scan
  - Quantity takeoff
- 4D Planning and Scheduling
  - Site logistics planning
  - Construction sequencing
  - Data loaded 4D schedule



Robotic Total Station Layout

- Total station setup is based on reference points (typically survey control points either onsite or offsite, on ground, or prisms/retroreflective targets)
- Then total station tracks the layout technician or field engineer who holds the prism pole and directs the technician to the actual concrete element location for staking.
- Layout technician chooses the element to stake from a digital file (2D CAD linework, or 3D model) on a data collector

OR

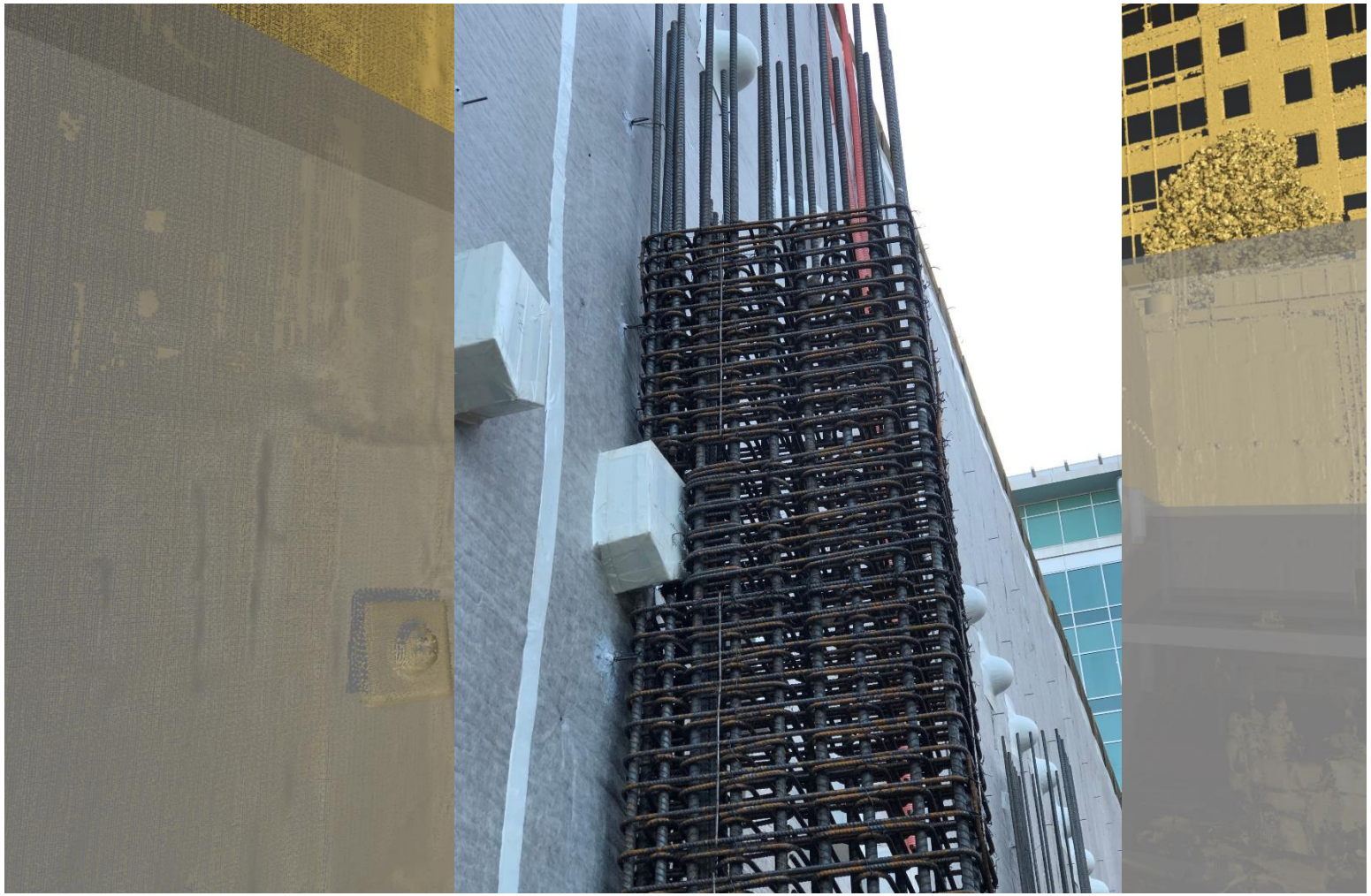
3D Laser Scanning - Introduction

Leica P40 Scan Station

3D Laser Scanning (LiDAR) (Terrestrial) – The scanner rotates 360 degrees horizontally with the sensor spinning and emitting laser simultaneously to collect dimensional data by up to millions of points per second. The product that it generates is called a point cloud. Because the point cloud is so dense, it looks almost like a 3D model, which can be used to virtually check dimensions, locations, deviations, etc.

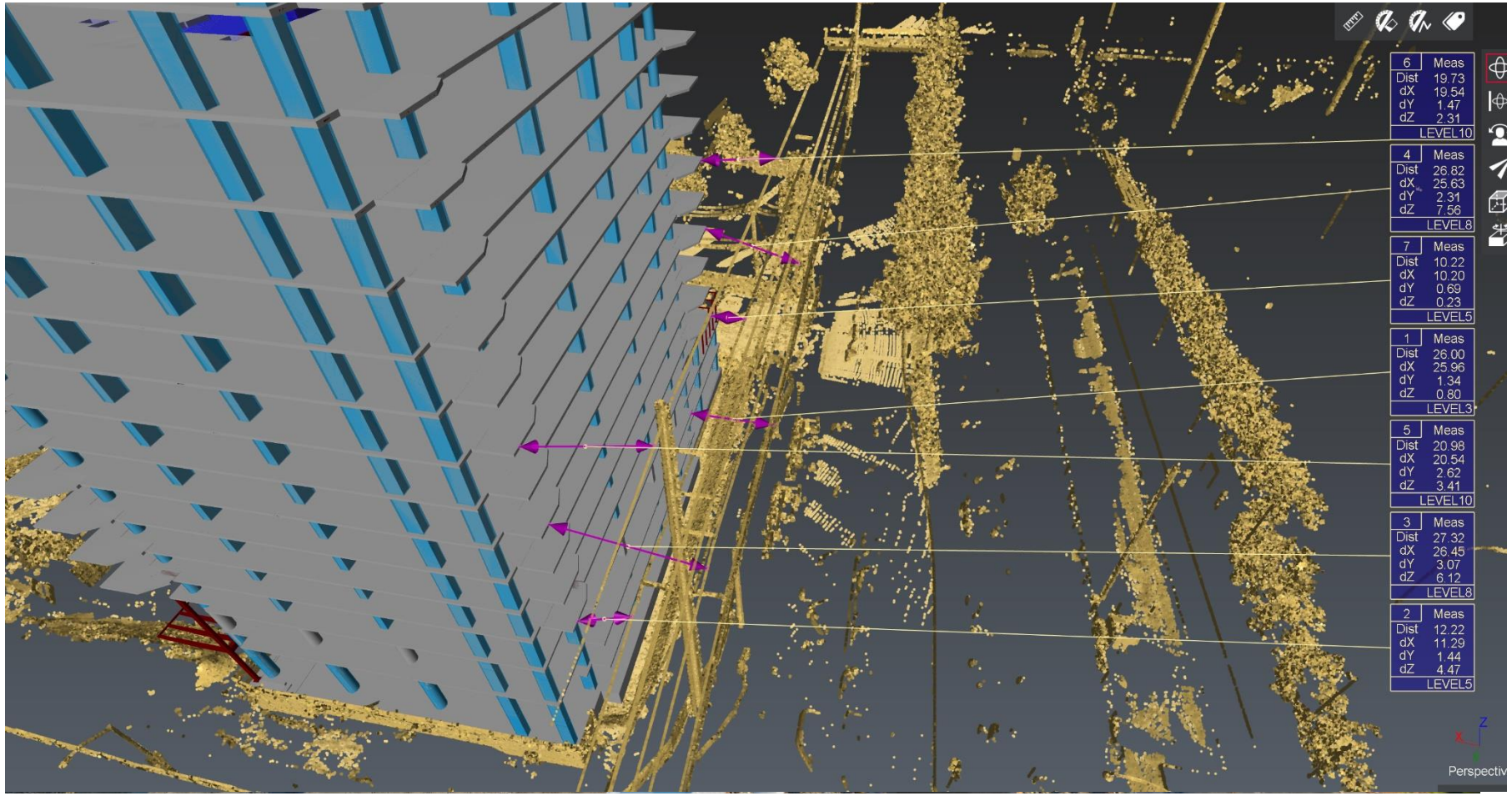
The concrete industry now has access to numerous LiDAR applications throughout the project lifecycle. For example, a site can be laser scanned during the planning phase and preconstruction phase to evaluate staging, safety, and truck routing. It can be also used as a quality assurance tool for verifying the size and location of reinforcing as well as the location of formwork, slab edges, openings, soffit elevations, or embedded elements. Some contractors use laser scanning to improve the quality of flatwork finishing operations and verify compliance with tolerance limits. And in-time laser scan deliverables can be used for building information modeling (BIM) coordination by mechanical, electrical, plumbing (MEP), and framing trades.

3D Laser Scanning – Example 1 (Lagging Wall)



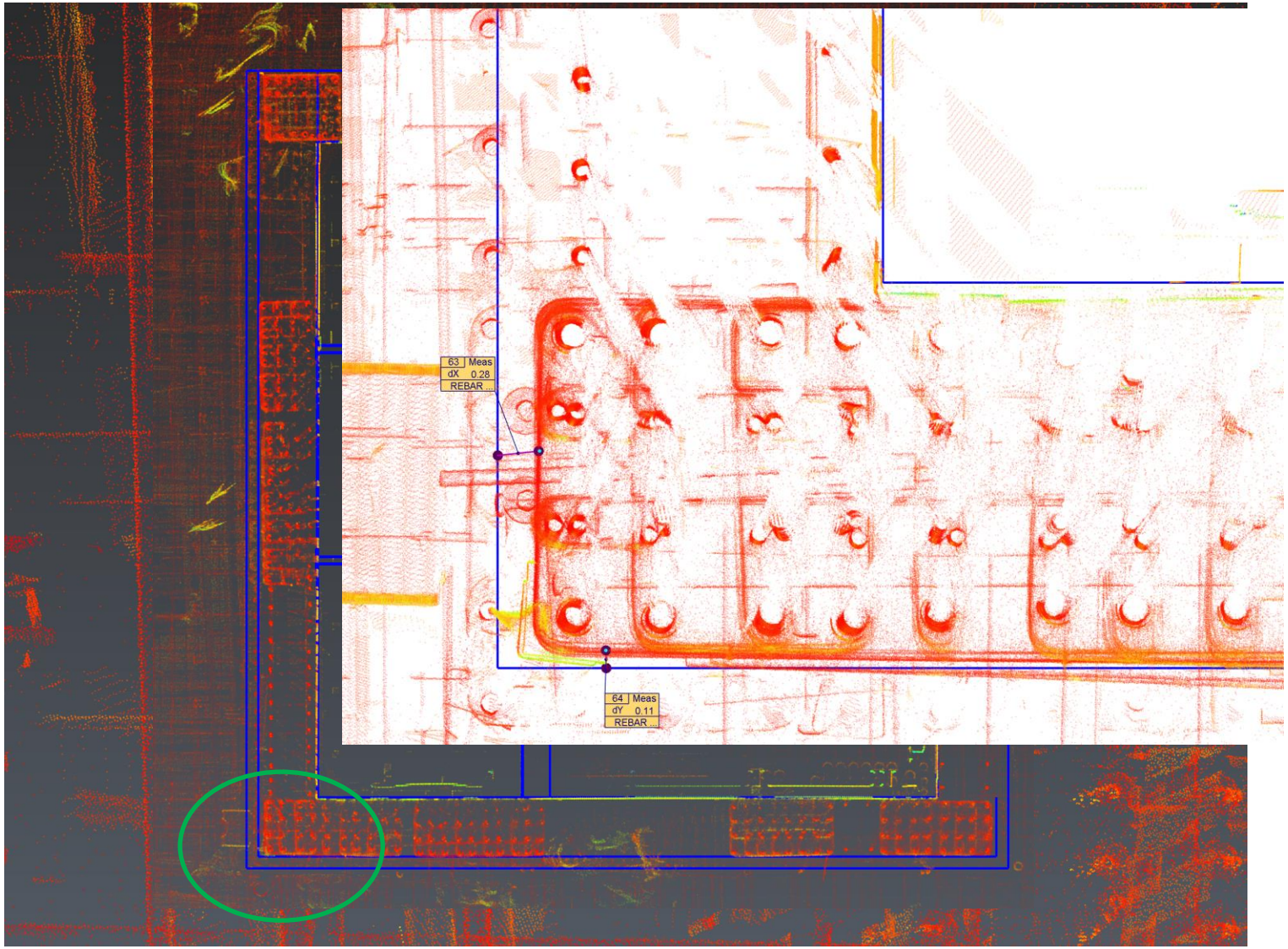
- This project has four levels below-grade shotcrete perimeter walls with pilasters
- The purpose of scanning the shoring wall was to identify the potential clashes between tieback blockouts and pilaster boundary bars for rebar prefabrication
- Laser scan included survey controls in XYZ and was localized and aligned to model coordinates for overlaying
- Streamlined from field laser scan survey to rebar detailing to fabrication and back to field installation

3D Laser Scanning – Example 2 (Safety)



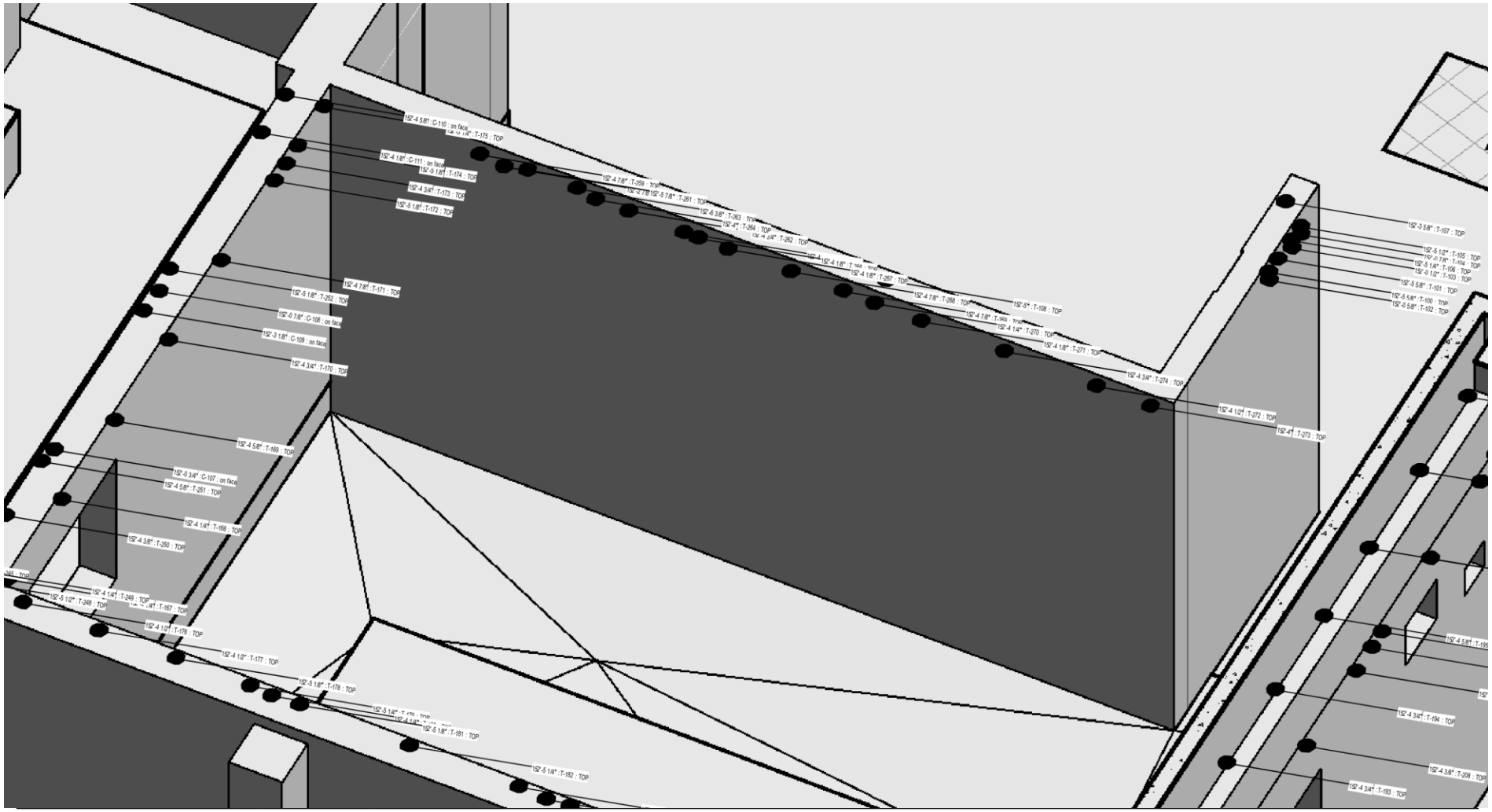
- The purpose of scanning the powerline was to identify the potential safety hazards with high voltage powerline before mobilization
- Laser scan included survey controls in XYZ and was localized and aligned to model coordinates for overlaying
- Level 5 – distance between powerline and slab edge – 10 feet
- Level 3 – distance between powerline and slab edge – 26 feet

3D Laser Scanning – Example 3 (Pre pour)



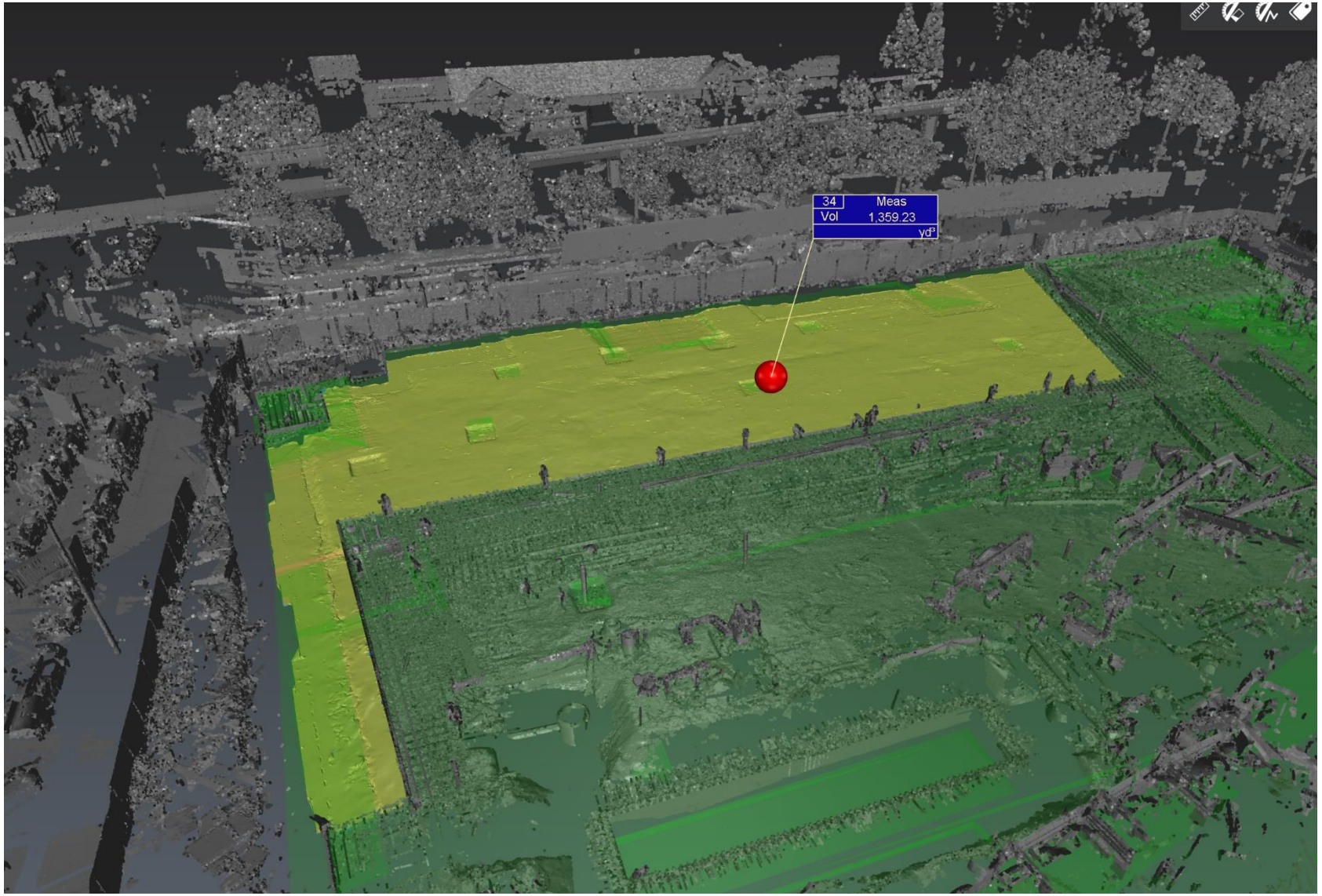
- Scanning on the soffit prior to pour as a quality assurance procedure to ensure embeds, formwork, rebar dowels/boundaries are in the right place and with enough clearance
- Laser scan included survey controls in XYZ and was localized and aligned to model coordinates for overlaying

3D Laser Scanning – Example 4 (Post pour)



- Once the laser scan point cloud has been registered to survey controls, it can be used to compare with 2D CAD linework or the construction 3D model for concrete element deviation analysis
- Format can be in numerical annotations, “heat map” or a combination of both

3D Laser Scanning – Example 5 (Quantity Takeoff)



- A 3D mesh or Digital Terrain Model (DTM) can be generated from a laser scan prior to the slab pour
- Quantity takeoff can be performed by comparing the scan mesh model and the top-of-slab model to capture the volume deviation from design due to field conditions (i.e. uneven subgrade surface, overdug slab thickening or footing, benchmark discrepancy, construction joint location, etc) and save your concrete order

4D Planning and Scheduling

Site Logistics Planning

- 4D planning and scheduling is another way to present and manage schedules virtually adding a “4th dimension - timeline” to a 3D model by combining traditional construction schedule and 3D model

- Pros
  - Stakeholders buy-in
  - Improve communication and avoid schedule clashes
  - An upgrade of existing CPM scheduling, or last planner system

- Cons
  - Time/Cost

4D Planning and Scheduling

Highrise Cycle Sequence

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4D Planning and Scheduling

Construction Sequencing

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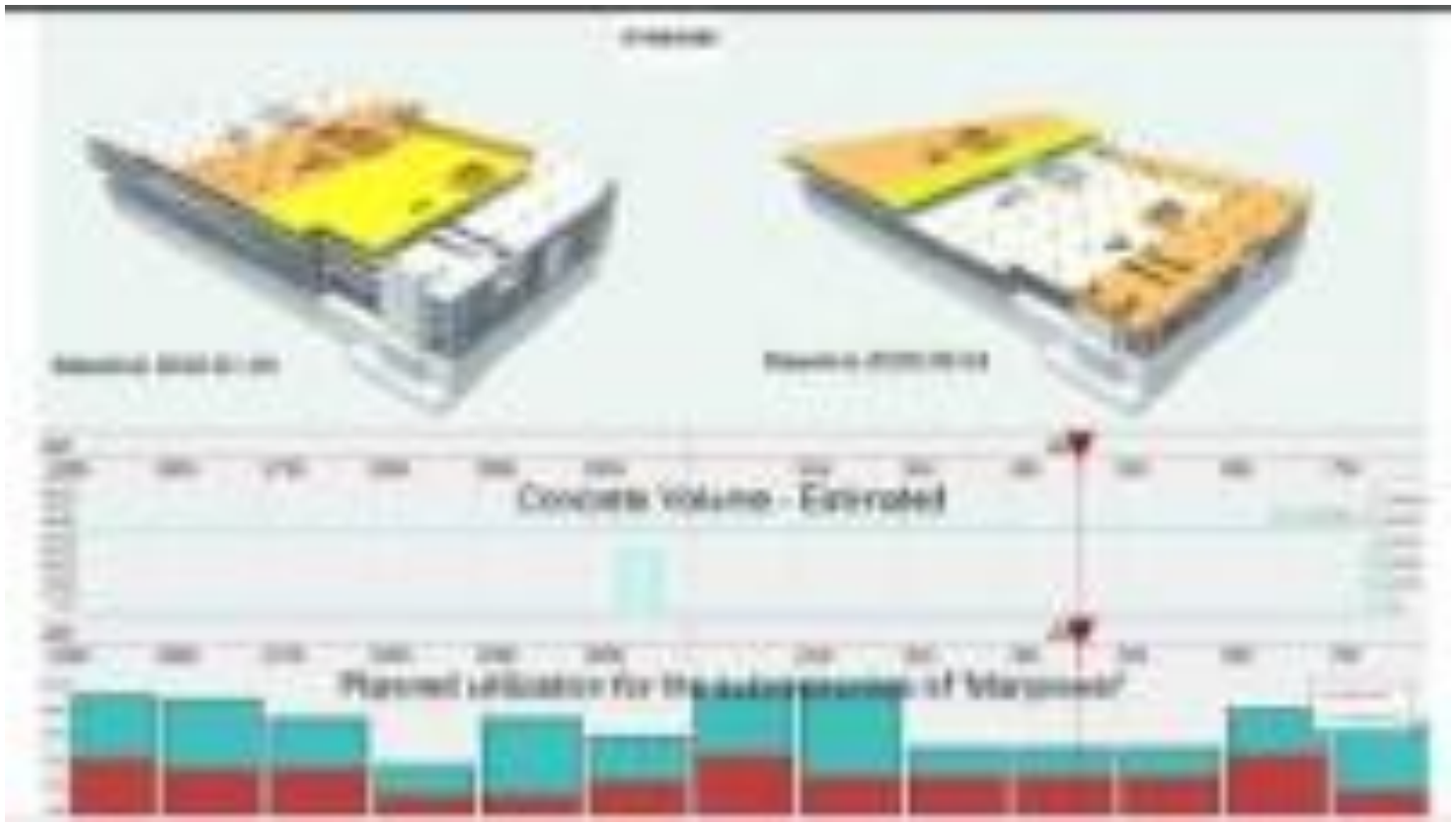
4D Planning and Scheduling



Data Loaded Baseline Schedule Comparison

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Digital Twin

Industry 4.0

Artificial Intelligence

IoT

BUZZWORD?

2D/3D/4D/5D/6D/7D/nD?

Virtual Design Construction (VDC)

Further thoughts

Innovation for the concrete industry is GREAT

When it has boots on the ground and iterates to solve real-world challenges

Thank you!