The Top 10 Ways to Reduce Concrete's Carbon Footprint

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NRMCA

BUILD WITH STRENGTH

UN Environment Global Status Report

- 2.5 Trillion sq ft of new construction by 2060
- Double existing building stock
- Design disaster resilient buildings
- Design zero-energy buildings
- Reduce embodied impacts

No. 1:

Communicate Carbon Reduction Goals

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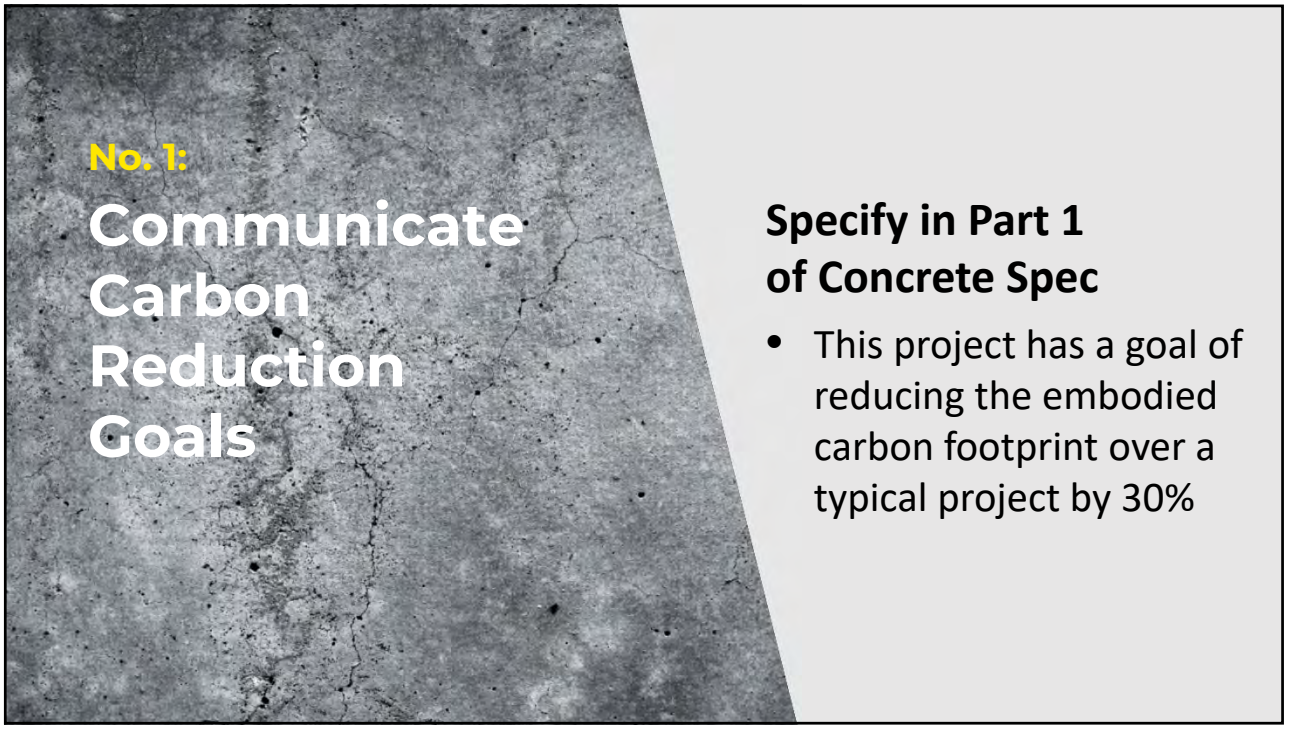
Communicate Carbon Reduction Goals

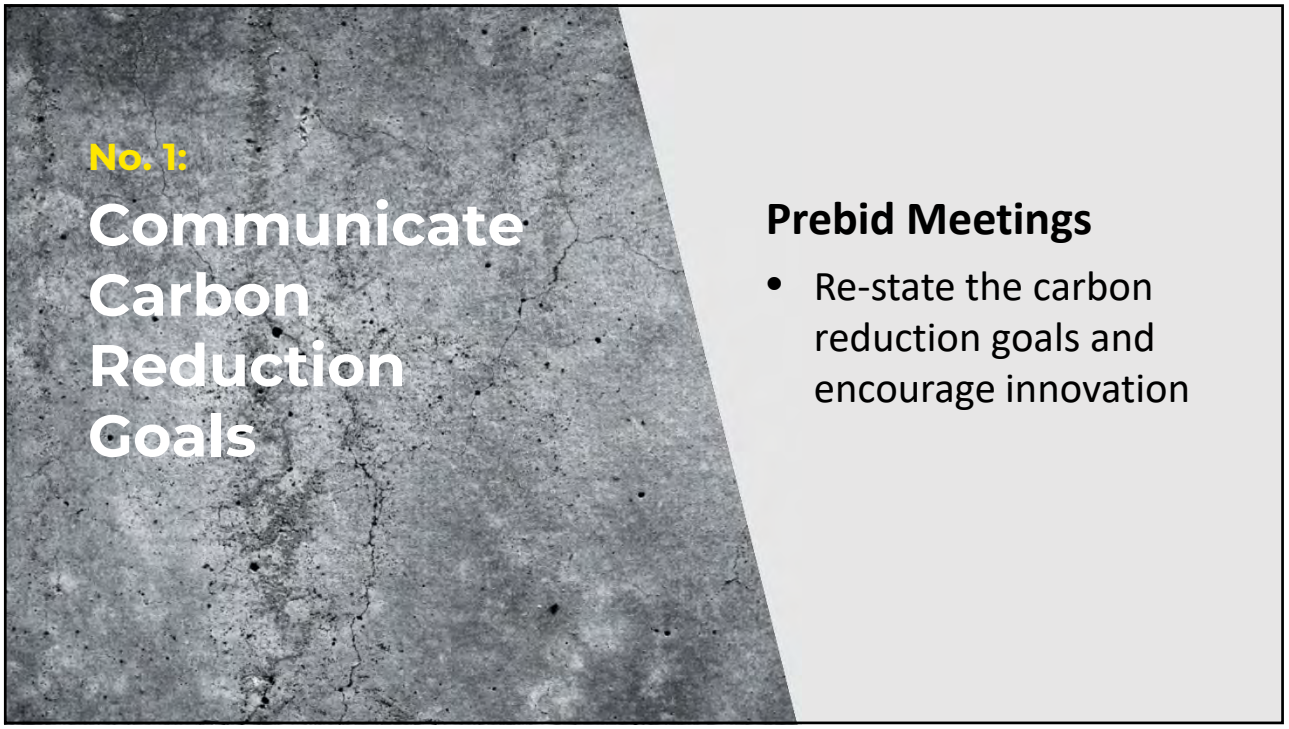
Collaborate during design process

- Meetings and charettes



Specify in Part 1 of Concrete Spec

- This project has a goal of reducing the embodied carbon footprint over a typical project by 30%



Prebid Meetings

- Re-state the carbon reduction goals and encourage innovation

Manufacturer Qualifications:

- NRMCA Certified Concrete Production Facility
- NRMCA Concrete Technologist Level 2

No. 2:
Ensure Good Quality Control and Assurance

Installer Qualifications:

- ACI Flatwork Finisher

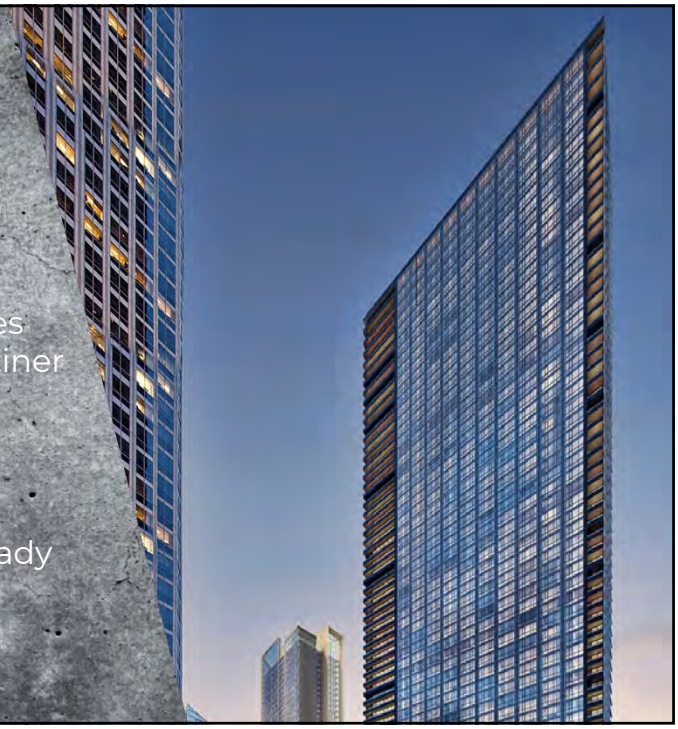
Testing Agency Qualifications:

- Meets ASTM C1077
- ACI Concrete Field Testing Technician Grade I
- ACI Concrete Laboratory Testing Technician Level I
- Results certified by a registered design professional

Case Study: 960 W. 7th, Los Angeles

- 64-story tower
- 780 residential units
- 807,000 square feet

- Developer: Brookfield Properties
- Design Architect: Marmol Radziner
- Executive Architect: Large Architecture
- Structural Engineer: MKA
- Contractor: Webcor
- Concrete Supplier: National Ready Mixed Concrete Company
- Photos: Brookfield Properties



Challenges

- Balancing cost, long term value, energy efficiency, occupant comfort and sustainability
- The design team, developer, contractor and product suppliers have the same goals
- Reducing environmental impact, including carbon footprint.

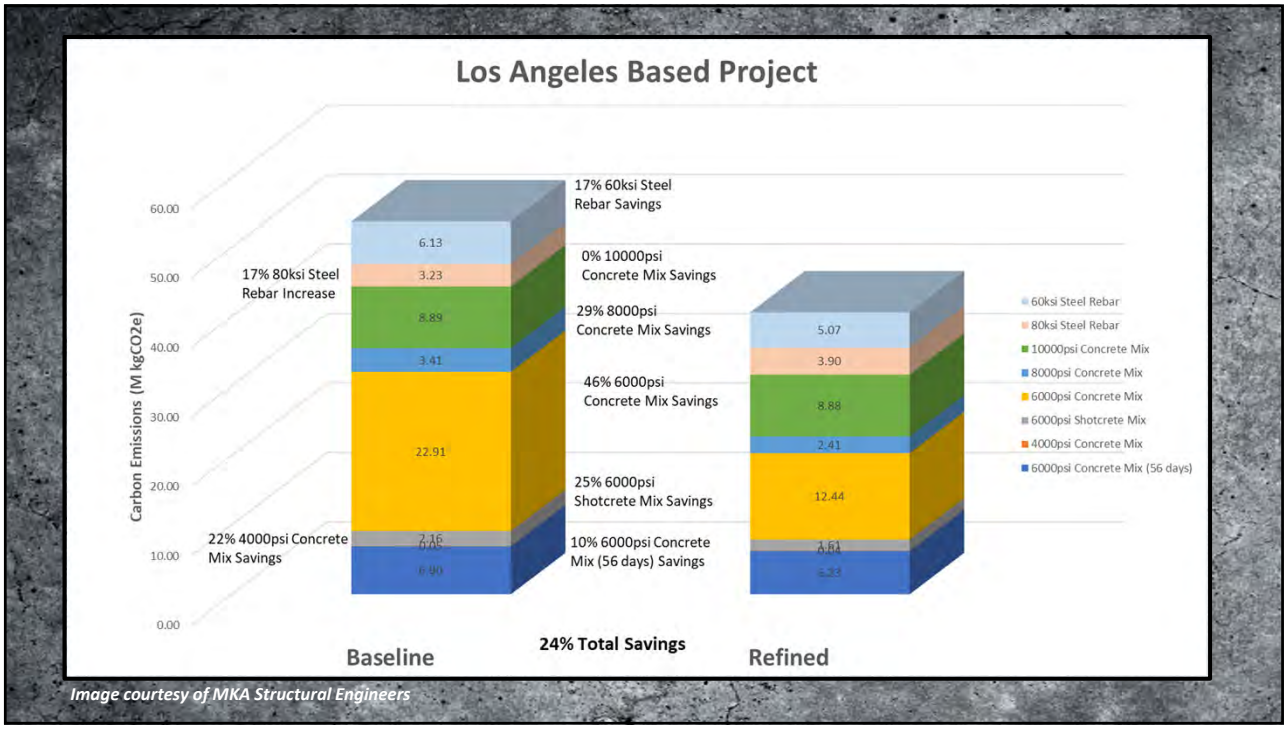
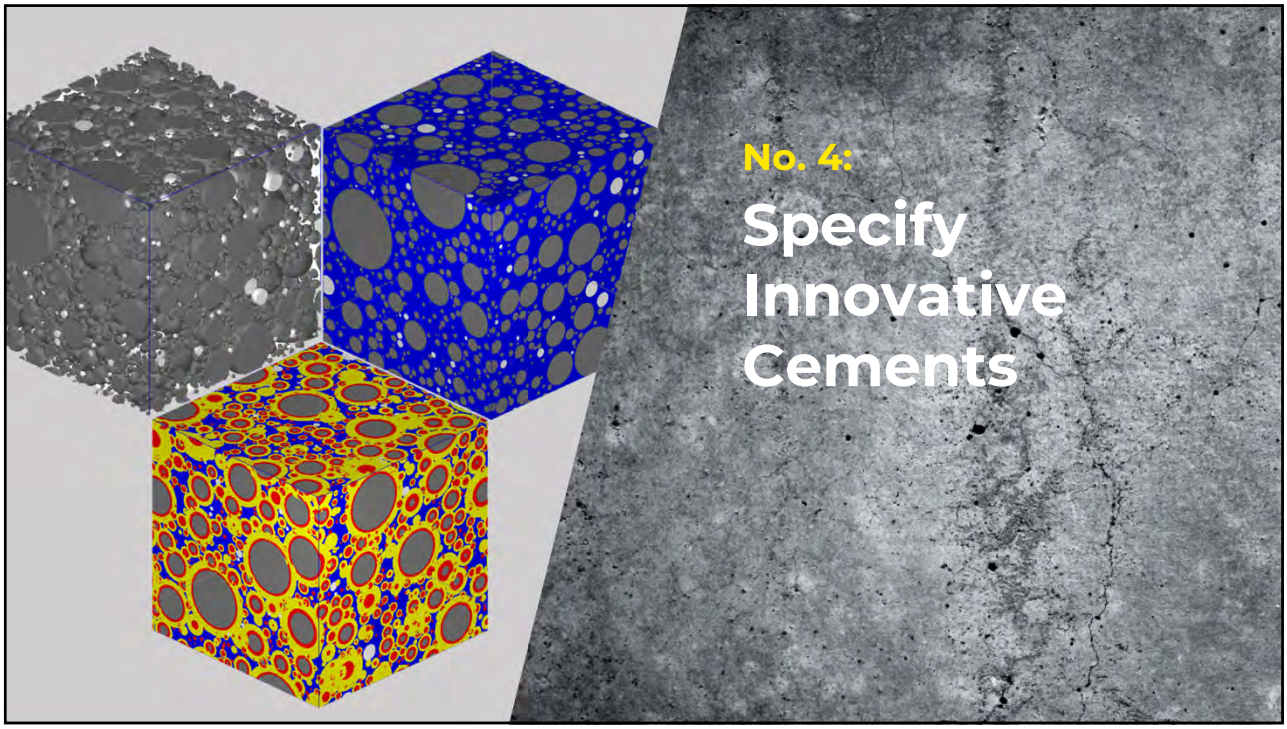


Image courtesy of MKA Structural Engineers



ASTM C595

Type	Description	Notes
Type IL (X)	Portland-Limestone Cement	Where X can be between 5 and 15% limestone
Type IS (X)	Portland-Slag Cement	Where X can be up to 70% slag cement
Type IP (X)	Portland-Pozzolan Cement	Where X can be up to 40% pozzolan (fly ash is the most common)
Type IT (AX)(BX)	Ternary Blended Cement	Where X can be up to 70% of pozzolan + limestone + slag, with pozzolan being no more than 40% and limestone no more than 15%

No. 4:

Specify Innovative Cements

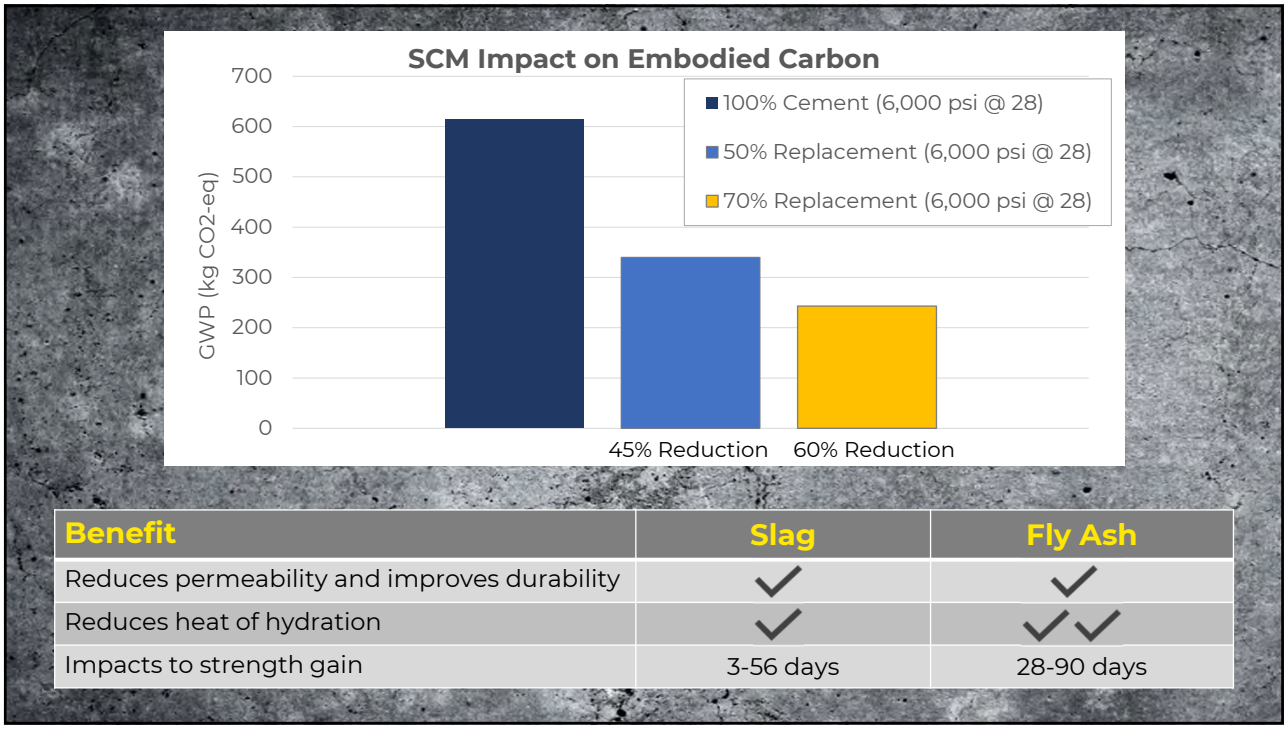
Concrete Materials:

- **Hydraulic Cement:** ASTM C150, ASTM C595, or ASTM C1157

No. 4:

Specify Innovative Cements


No. 5:
Specify Supplementary Cementitious Materials



Benefit	Slag	Fly Ash
Reduces permeability and improves durability	✓	✓
Reduces heat of hydration	✓	✓✓
Impacts to strength gain	3-56 days	28-90 days

No. 5:

Specify Supplementary Cementitious Materials

Concrete Materials:

A. Cementitious Materials: use materials meeting the following requirements:

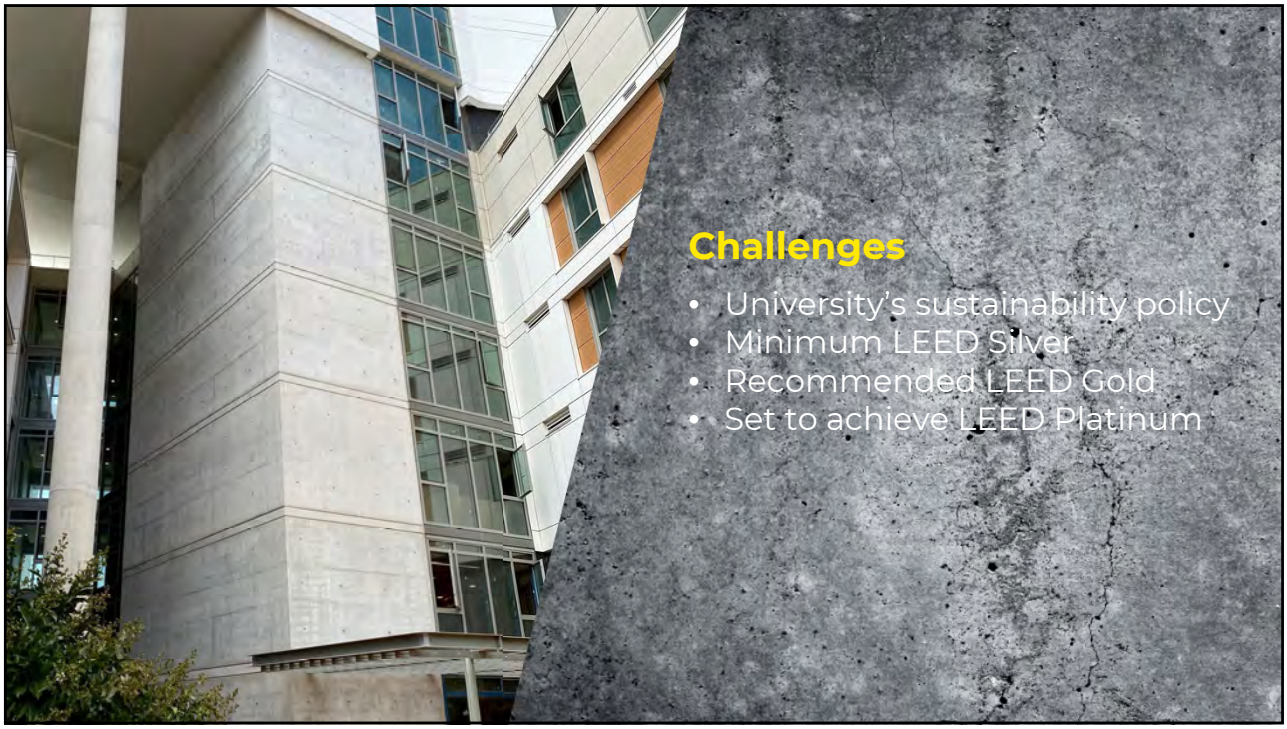
1. Hydraulic Cement: ASTM C150, ASTM C595, or ASTM C1157
2. **Fly Ash or Natural Pozzolan: ASTM C618**
3. **Slag Cement: ASTM C989**
4. **Silica Fume: ASTM C1240**
5. **Glass Pozzolan: ASTM C1866**

Case Study: UC San Diego, North Torrey Pines Living and Learning Neighborhood

- 10 acres of academic, residential and commercial buildings
- Housing for 2,000 students

- Contractor: Clark Construction
- Architects: HKS in association with Safdie Rabines Architects
- Concrete Specialists: CalPortland

Photo: Courtesy of Walter Kanzler



Challenges

- University's sustainability policy
- Minimum LEED Silver
- Recommended LEED Gold
- Set to achieve LEED Platinum

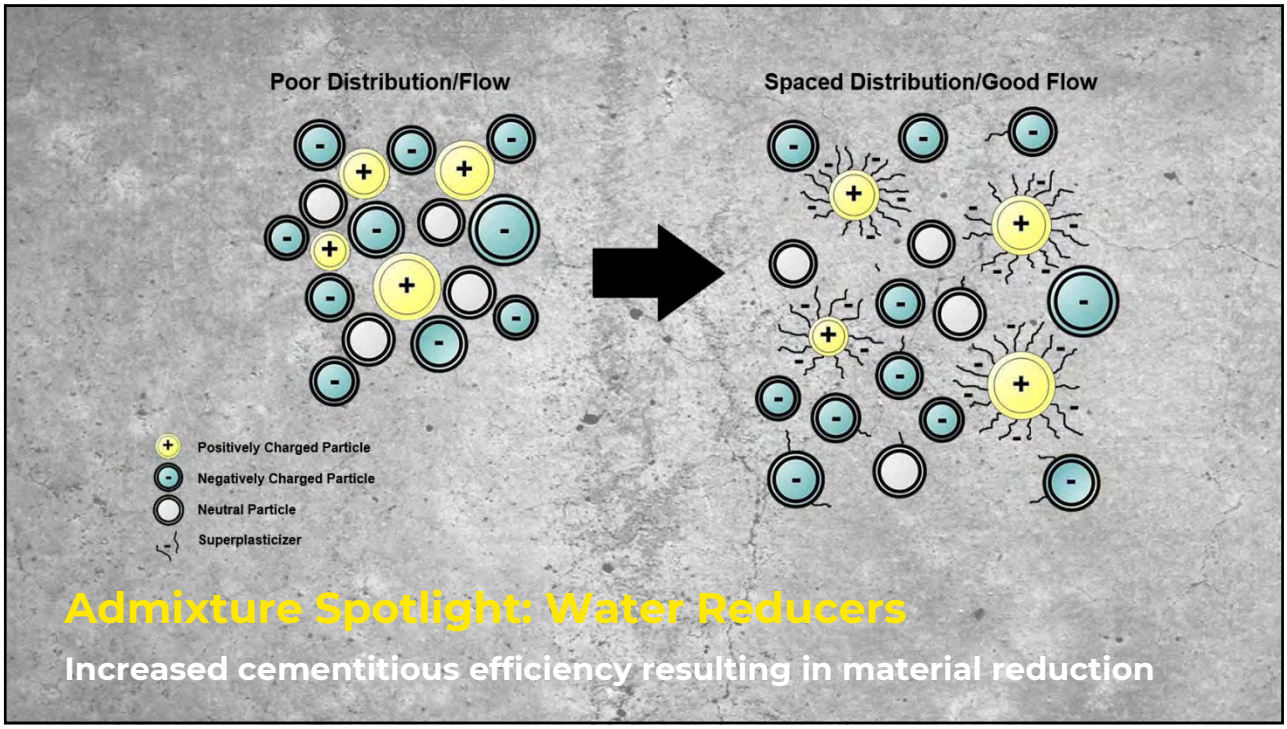
Cement Type	Global Warming Potential
Portland Limestone Cement Type IL (13)	871 kg CO_2eq
Portland Cement Type I/II/V	969 kg CO_2eq

Sustainable Solutions

- Life Cycle Analyses (LCAs)
- Demonstrate sustainable design and outcomes
- Used Type IL blended portland-limestone cement
- Save 3,055 metric tonnes of CO_2

No. 6:

Specify Admixtures



Concrete Materials:

Chemical Admixtures:

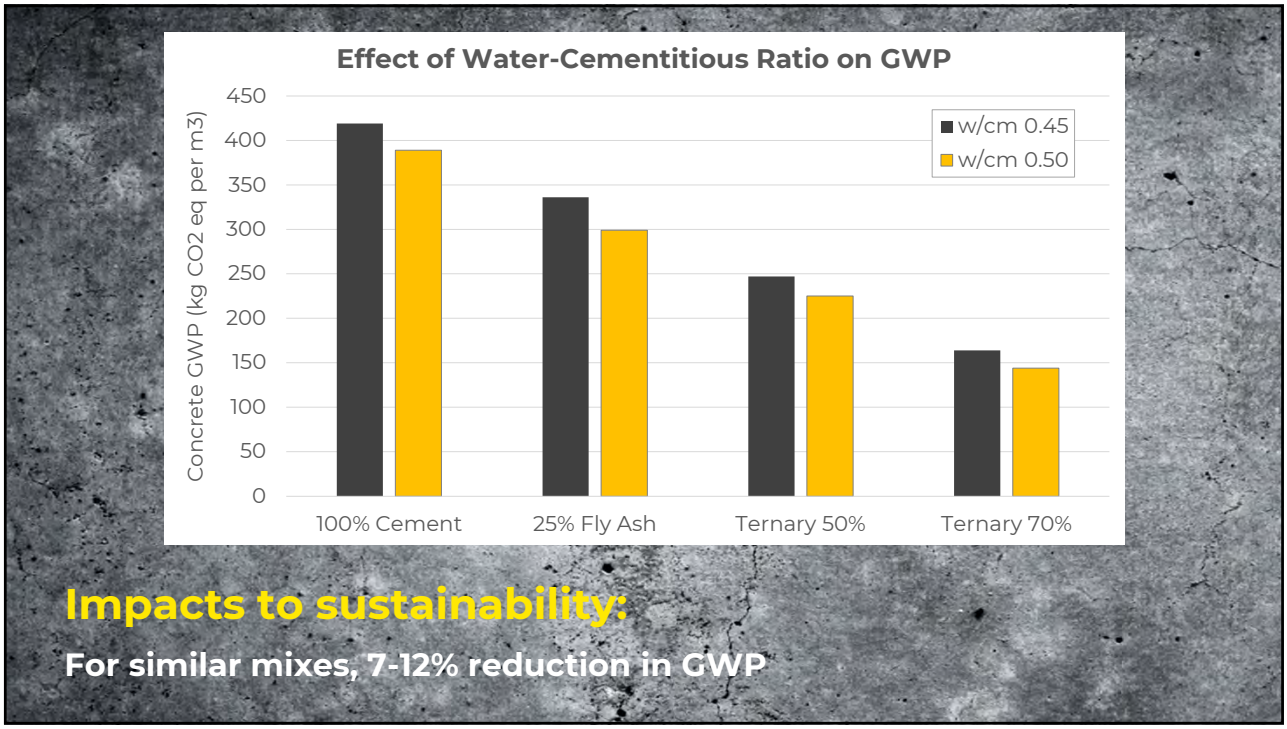
1. Air-Entraining Admixture: ASTM C 260/C 260M
2. Water-Reducing Admixture ASTM C 494/C 494M Type A
3. High-Range Water-Reducing Admixture: ASTM C 494/C 494M Type F or G
4. Accelerating Admixture: ASTM C 494/C 494M Type C or E
5. Retarding Admixture: ASTM C 494/ C 494M Type B or D
6. Hydration Control Admixture: ASTM C 494/C 494M Type B or D
7. Specialty Admixtures: ASTM C 494/C 494M Type S

No. 6:

Specify Admixtures

No. 7:
Don't Limit Ingredients

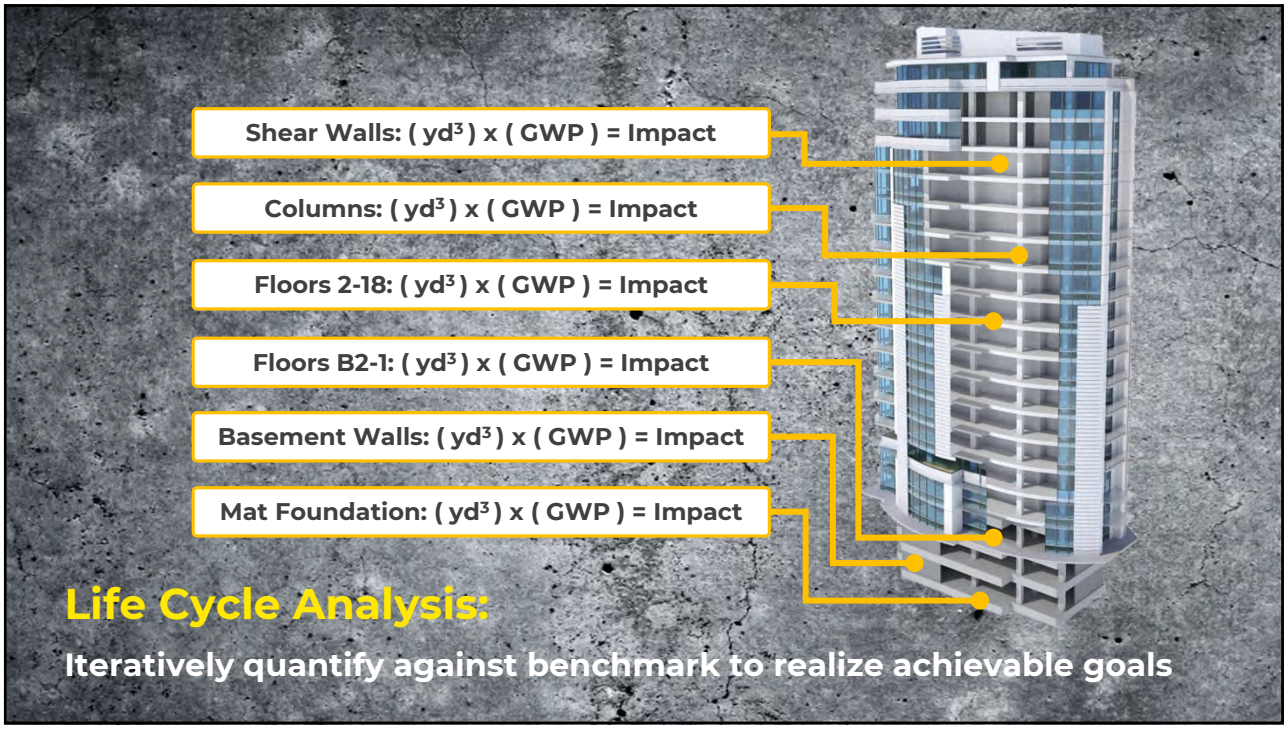
- ~~Maximum w/cm ratio~~
- ~~Air content of 6% for all concrete~~
- ~~Maximum cement content~~
- ~~Minimum cement content~~
- ~~Maximum fly ash content~~
- ~~Minimum fly ash content~~
- ~~Water: Potable~~



No. 7:

Don't Limit Ingredients

Class	Location	Nominal Max. Aggregate Size	Exposure Class	F'c, Psi @ Age
1	Mat Foundation	3"	F0, S1, W0, C0	6,000 at 90 days
2	Basement Walls	1-1/2"	F0, S1, W0, C0	4,000 at 56 days
3	Shear Walls	3/4"	F0, S0, W0, C0	6,000 at 56 days
4	Columns Level B2-L6	3/4"	F0, S0, W0, C0	6,000 at 28 days
5	Columns Level L7-L12	3/4"	F0, S0, W0, C0	4,000 at 28 days
6	Slabs	3/4"	F0, S0, W0, C0	5,000 at 28 days
7	Exterior Pavements	3/4"	F3, S1, W0, C0	4,000 at 28 days



Concrete Materials:

B. Supply concrete mixtures such that the total Global Warming Potential (GWP) of all concrete on the project is less than or equal to 4,298,000 kg of CO2 equivalents.

No. 8:

Set Targets for Carbon Footprint

Carbon Uptake:

CO_2 + Ca = $CaCO_3$

Atmospheric Carbon Dioxide

Calcium Byproducts in Hardened Concrete

Recombines into Limestone

No. 9:

Sequester Carbon Dioxide

Concrete Materials:

A. Normal-weight Aggregate: ASTM C33
B. Lightweight Aggregate: ASTM C330
C. Recycled concrete aggregate (crushed concrete) meeting the requirements of ASTM C33 or ASTM C330 may be used in structural concrete up to 10% of the total aggregate. Crushed concrete shall have been crushed and exposed to air at least 1 year before use in concrete (to maximize CO2 sequestration).

No. 9:

Sequester Carbon Dioxide

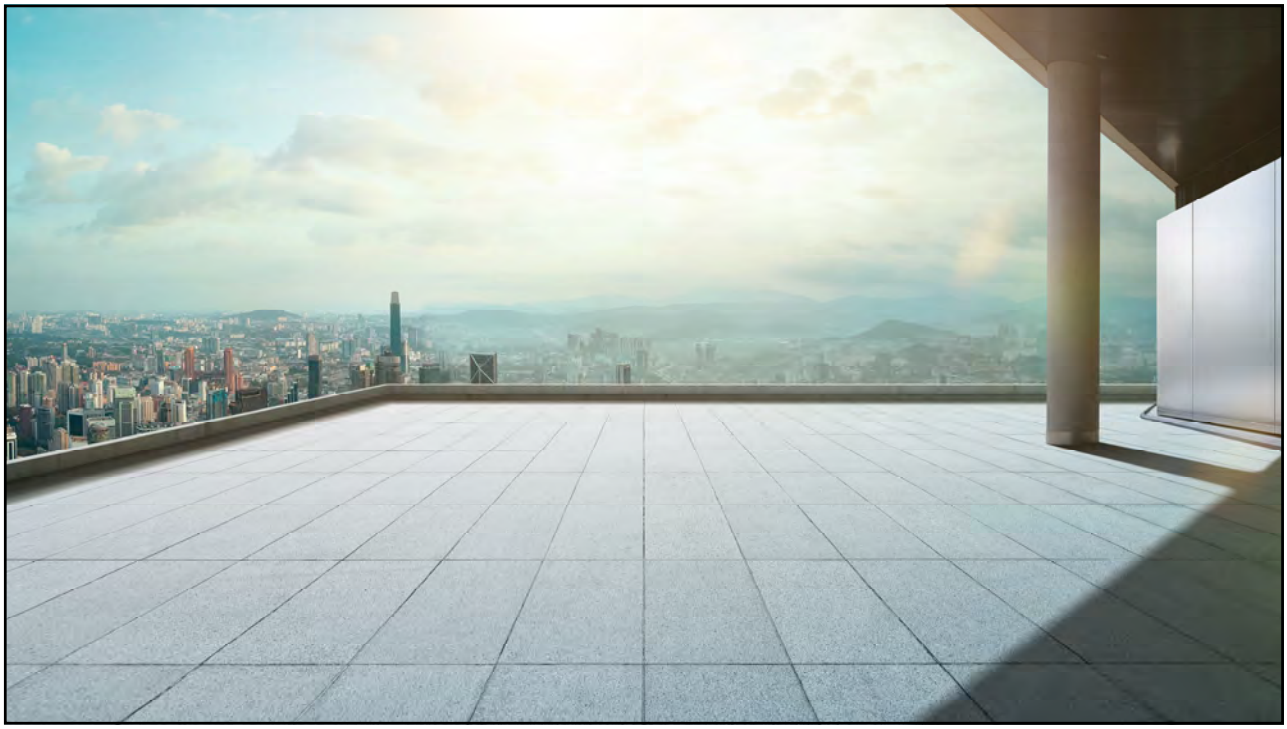
Concrete Materials:

D. Carbon mineralization by injecting CO2 into concrete during manufacturing or curing in CO2 atmosphere shall be permitted.

E. Artificial limestone aggregate meeting the requirements of ASTM C33 or ASTM C330 is permitted.

No. 10:

Encourage Innovation



The Top 10 List

1. Communicate Carbon Reduction Goals
2. Ensure Good Quality Control and Assurance
3. Optimize Concrete Design
4. Specify Innovative Cements
5. Specify Supplementary Cementitious Materials
6. Specify Admixtures
7. Don't Limit Ingredients
8. Set Targets for Carbon Footprint
9. Sequester Carbon Dioxide in Concrete
10. Encourage Innovation