Proposed 2024 Building Code Update
Low Carbon Concrete Code

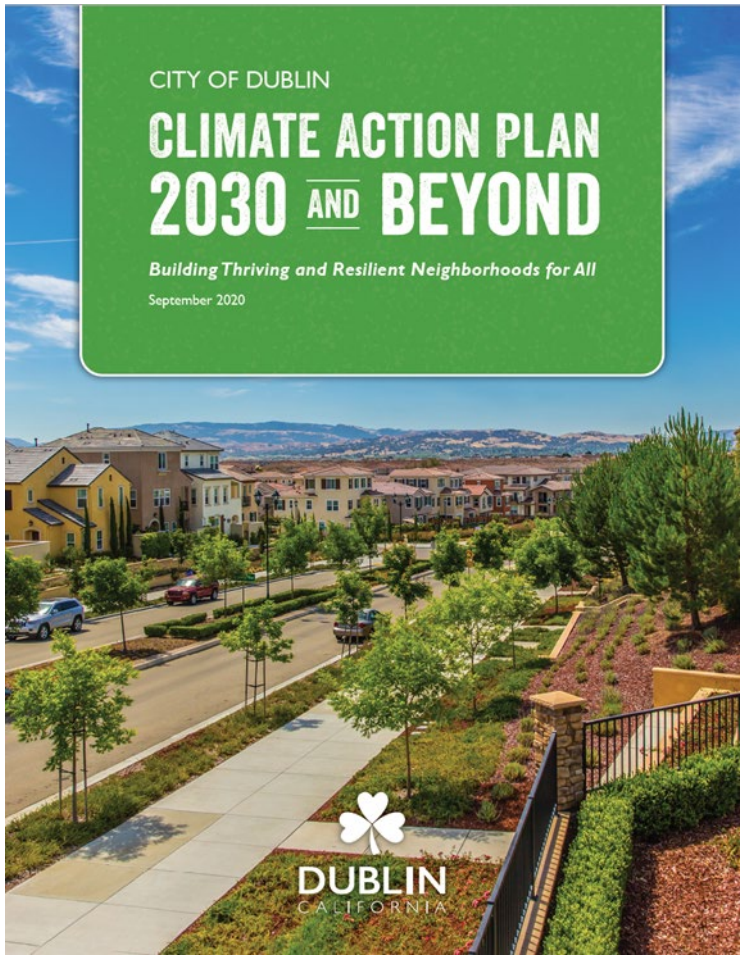
April 10, 2024

DUBLIN
CALIFORNIA

Agenda

1. Brief overview of the City's Climate Action Plan 2030 and Beyond
2. Overview of Low Carbon Concrete Code
3. Example Projects and Calculations
4. Next Steps & Questions

Climate Action Plan 2030 and Beyond

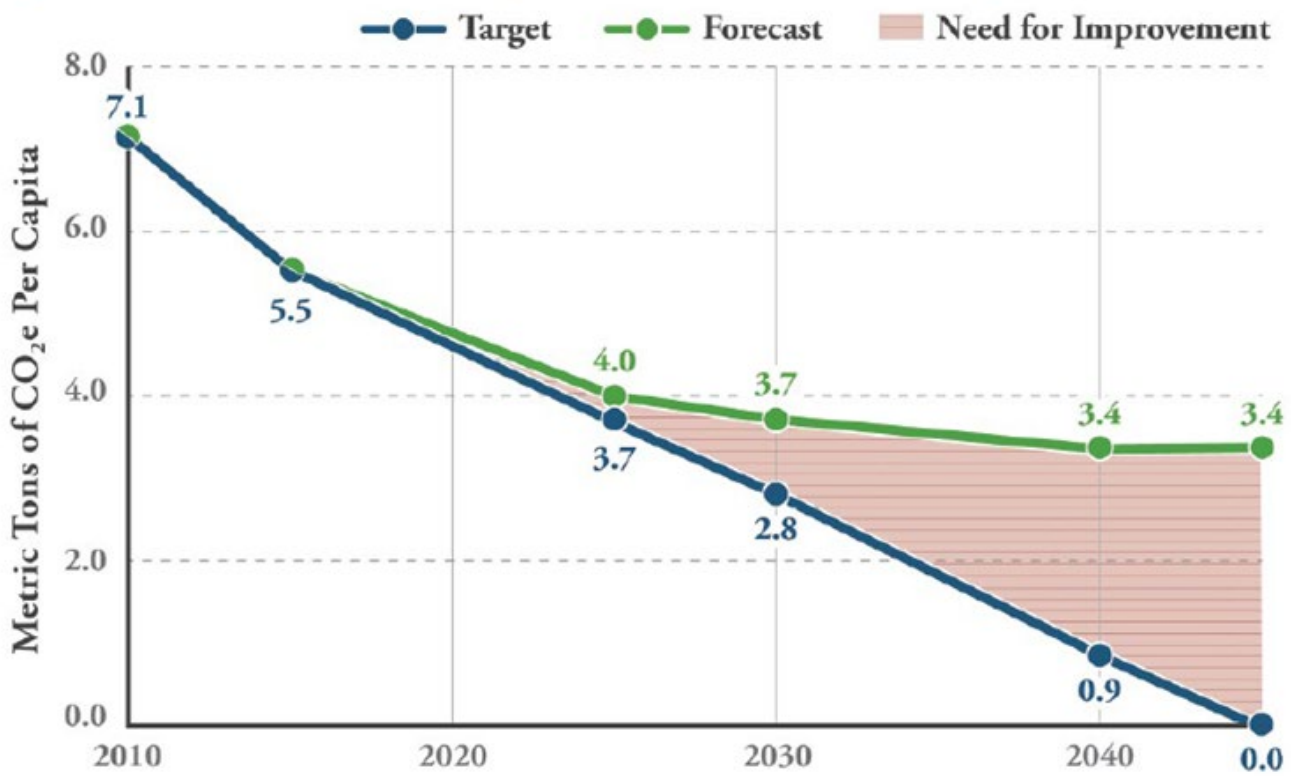


Five strategies in Climate Action Plan 2030 and Beyond (CAP 2030)

- Renewable and carbon free electricity (CF)
- Building efficiency and electrification (EE)
- Sustainable Mobility and Land Use (SM)
- Materials and Waste Management (MM)
- Municipal Leadership (ML)

Greenhouse Gas (GHG) Emissions

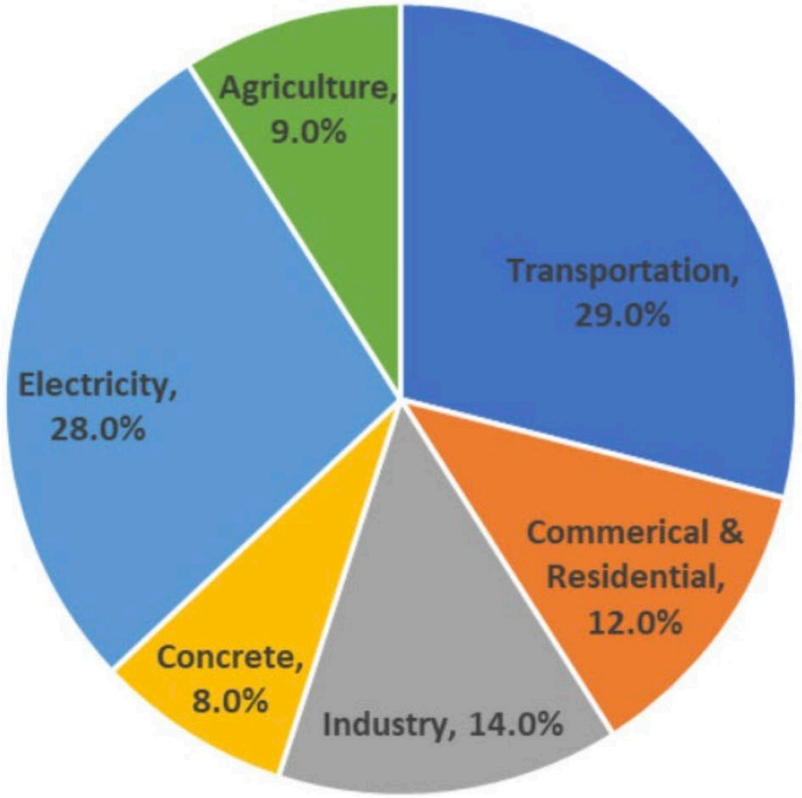
Figure 4-3: Dublin GHG Emissions Adjusted Forecast and Reduction Targets



CAP 2030 and Beyond Measures

- Measure CF-1: Opt-Up to 100% Renewable and Carbon-Free Electricity
- Measure EE-1: Achieve All-Electric New Building Construction
- Measure EE-4: Develop an Existing Building Electrification Plan
- Measure SM-1: Adopt an Electric Vehicle Charging Station Ordinance
- Measure SM-2: Develop an EV Infrastructure Plan
- SM-5: Update the Bicycle And Pedestrian Master Plan
- Measure MM-1: Achieve the Organic Waste Requirements of SB 1383
- **Measure MM-2: Reduce the Embodied GHG Emissions Associated with Building Materials**
- Measure ML-4: Total Cost of Ownership and Life-Cycle Analysis of GHG Impacts on Municipal Project Request for Proposals
- ML-5: Promote Municipal Awareness of Sustainable Goods and Services
- Measure ML-6: Enhance Municipal Carbon Sequestration Opportunities

Portland Cement Carbon Emissions and LCC



https://psci.princeton.edu/tips/2020/11/3/cement-and-concrete-the-environmental-impact

- Concrete industry accounts for 8% of global carbon emissions and 50-85% of the embodied carbon in buildings
- 1 ton of Portland cement = 1 ton of CO_2 emitted.
- Low carbon concrete (LCC) reduces the carbon footprint by incorporating crushed limestone, supplementary cementitious materials (SCMs) and/or changing the fuel source used in the kiln.
- Crushed limestone and SCMs have been used for years and can reduce the cost of producing concrete

LCC Code Presentation

Taylor Briglio
Senior Project Manager
Willdan

- *7 Years Energy and Transportation Experience*
- *Focus on Public Sector*
- *EV Infrastructure Planning*
- *Fleet Electrification*

Brian Moss
Project Manager
Willdan

- *30+ Years Municipal and State Code Experience*
- *30+ years in Public Administration*
- *30+ years in Regulatory Oversight*
- *Focus on Public Sector*

Key Highlights – Low Carbon Concrete (LCC) Code

Purpose

- Reduce embodied carbon of concrete

Applicable Projects

- Requires building permit AND
- Use ready-mix concrete

Impact

- Establishes limits on the Portland cement content and embodied carbon content in concrete. Varies by compressive strength
- Environmental Product Declarations (EPDs), batch certificates, and a LCC Compliance Form must be submitted to verify the concrete mixes comply with the limits

Exemptions

- Shotcrete, gunite, stucco, asphaltic concrete
- Bagged concrete (i.e. Quikrete)
- Hardship or infeasibility

LCC Limits

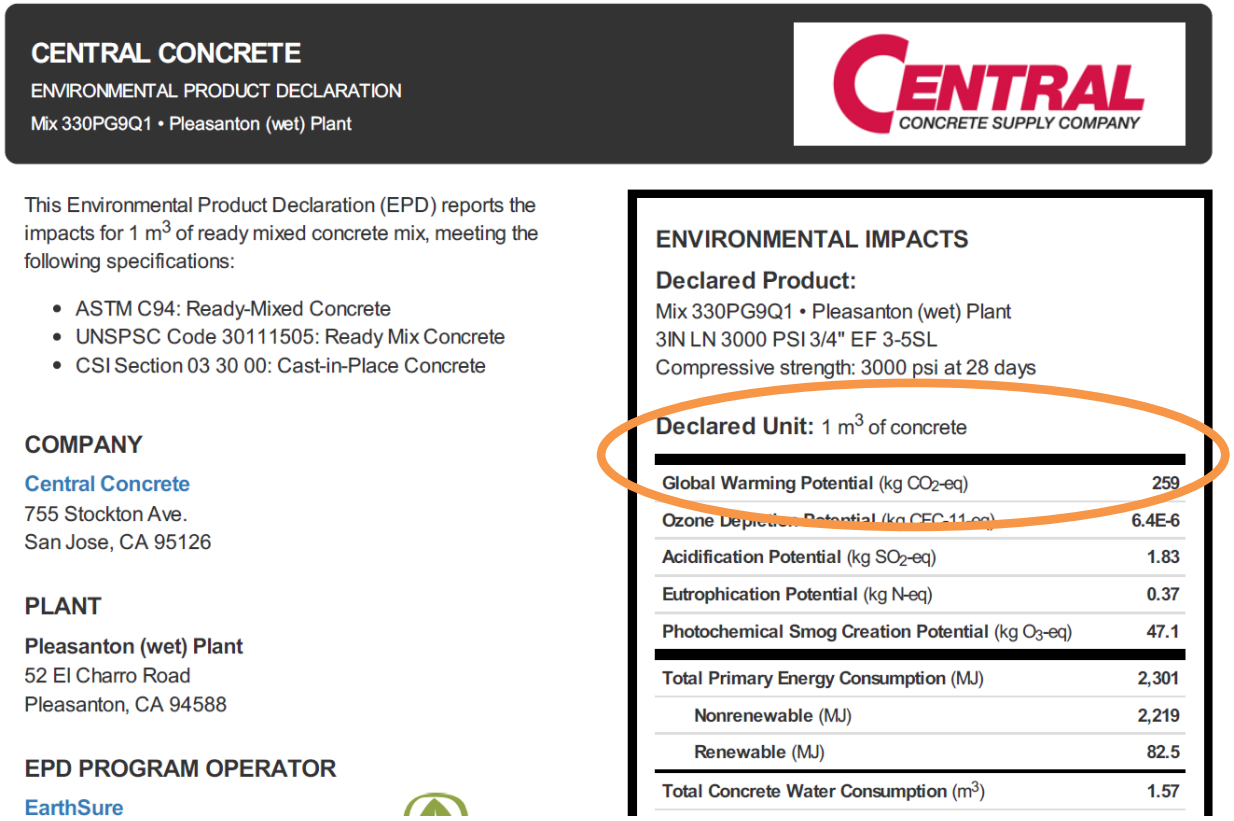
- Code establishes maximums for Portland cement and embodied carbon based on the required compressive strength of the concrete
- High early strength mixes can increase these limits by 30%
- When multiple mixes are used, limits are based on the sum-product of all mixes in the project

Table 4.420.3

	Cement limits	Embodied Carbon limits
Minimum specified compressive strength f'c , psi	Maximum ordinary Portland cement content, lbs/yd^3 (1)	Maximum embodied carbon kg CO_2e/m^3, per EPD
up to 2500	362	260
2501-3000	410	289
3001-4000	456	313
4001-5000	503	338
5001-6000	531	356
6001-7000	594	394
Greater than 7000	657	433
up to 3000 light weight	512	578
Up to 4000 light weight	571	626
4001-5000 light weight	629	675

Environmental Product Declaration (EPD)

- An EPD quantifies environmental information of a product based on the results of a comprehensive Life Cycle Assessment (LCA).
- Environmental Product Declarations have at least a "cradle to gate" scope.
- EPDs can be requested from ready-mix plants.



CENTRAL CONCRETE
ENVIRONMENTAL PRODUCT DECLARATION
Mix 330PG9Q1 • Pleasanton (wet) Plant

CENTRAL CONCRETE SUPPLY COMPANY

This Environmental Product Declaration (EPD) reports the impacts for 1 m^3 of ready mixed concrete mix, meeting the following specifications:

- ASTM C94: Ready-Mixed Concrete
- UNSPSC Code 30111505: Ready Mix Concrete
- CSI Section 03 30 00: Cast-in-Place Concrete

COMPANY
Central Concrete
755 Stockton Ave.
San Jose, CA 95126

PLANT
Pleasanton (wet) Plant
52 El Charro Road
Pleasanton, CA 94588

EPD PROGRAM OPERATOR
EarthSure

ENVIRONMENTAL IMPACTS

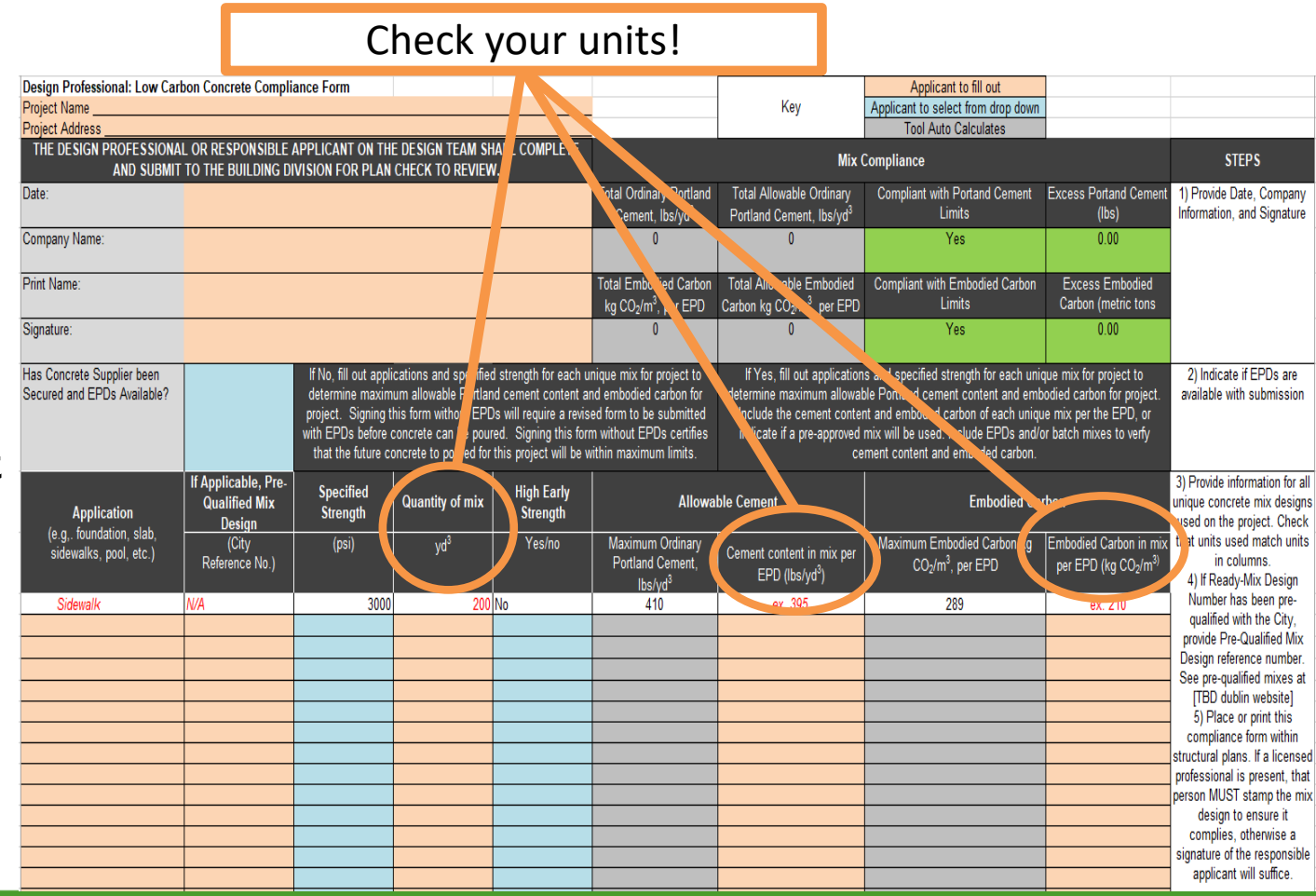
Declared Product:
Mix 330PG9Q1 • Pleasanton (wet) Plant
3IN LN 3000 PSI 3/4" EF 3-5SL
Compressive strength: 3000 psi at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	259
Ozone Depletion Potential (kg CFC-11-eq)	6.4E-6
Acidification Potential (kg SO_2-eq)	1.83
Eutrophication Potential (kg N-eq)	0.37
Photochemical Smog Creation Potential (kg O_3-eq)	47.1
Total Primary Energy Consumption (MJ)	2,301
Nonrenewable (MJ)	2,219
Renewable (MJ)	82.5
Total Concrete Water Consumption (m^3)	1.57

EPD Submittal and LCC Compliance Form

- EPDs must be submitted as part of the permit application.
- The LCC Compliance Form will help determine if the project meets LCC requirements.
- Contractors are encouraged to engage concrete suppliers before applying for permits.
- The LCC Compliance Form can be submitted without EPDs but must be signed certifying that the concrete will comply with requirements.
- A LCC Compliance Form with EPDs and batch certificates must be submitted to the Building & Safety Division before and after concrete is poured to verify project meets LCC requirements



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Checking for Compliance

Concrete Mix Design Submittal

Date Issued : 12/15/2022
Submittal No.: BA-057253
Project ID: 3084332-41323306
Version: 1 Plant: F31

Customer: Skyline Steel Inc.
Project: 6700 Dublin Blvd.

Usage: Low Carbon Mix

Mix Number : **1627035** **4PG 564 F 15%S 25%WR**

Material Type	Description	Standard	Design Quantity	Volume (ft3)
Cement	Type II/V Cement	C150	338 lb	1.72
Fly Ash	Class F Fly Ash	C618	85 lb	0.57
Slag	Slag Cement Grade 120	C989	141 lb	0.78
Coarse Aggregate	3/8" x #8 DOT	C33	1750 lb	10.46
Fine Aggregate	Con Sand	C33	1319 lb	7.98
Admixture	Water Reducer / Type A&D	C494	- -	-
Water	Water	C1602	36.0 gal	4.81
Water Reducer / Type A&D: 3.0 To 6.0 lq oz Per 100 lb of Cement		Air Content		0.67
		Yield	3934 lb	27

CEMEX

ENVIRONMENTAL PRODUCT DECLARATION
Mix 1627035 • Pleasanton Plant

This Environmental Product Declaration (EPD) reports the impacts for 1 m^3 of ready mixed concrete mix, for use in business-to-business (B2B) comunication meeting the following specifications:

- ASTM C94: Ready-Mixed Concrete
- UNSPSC Code 30111505: Ready Mix Concrete
- CSA A23.1/A23.2: Concrete Materials and Methods of Concrete Construction
- CSI Division 03-30-00: Cast-in-Place Concrete

COMPANY

CEMEX
10100 Katy Freeway, Suite 300
Houston, TX 77043

PLANT

Pleasanton Plant
1544 Stanley Boulevard
Pleasanton, CA 94566

EPD PROGRAM OPERATOR

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428

ENVIRONMENTAL IMPACTS

Declared Product:
Mix 1627035 • Pleasanton Plant
Description: 4PG 564 F 15% S 25% WR
Compressive strength: 4000 PSI at 28 days

Declared Unit: 1 m^3 of concrete (1 cyd)

Global Warming Potential (kg CO_2-eq)	236 (180)
Ozone Depletion Potential (kg CFC-11-eq)	1.22E-5 (3.23E-6)
Acidification Potential (kg SO_2-eq)	0.82 (0.63)
Eutrophication Potential (kg N-eq)	0.19 (0.15)
Photochemical Ozone Creation Potential (kg O_3-eq)	20.5 (15.7)
Abiotic Depletion, non-fossil (kg Sb-eq)	9.14E-6 (6.99E-6)
Abiotic Depletion, fossil (MJ)	1,643 (1,256)
Total Waste Disposed (kg)	0.86 (0.65)
Consumption of Freshwater (m^3)	3.53 (2.70)

Product Components: natural aggregate (ASTM C33), Portland cement (ASTM C150), slag cement (ASTM C989), fly ash (ASTM C618), batch water (ASTM C1602), admixture (ASTM C494)

Additional detail and impacts are reported on page three of this EPD

Equations

Cement Limit Equation 4.420.3.3:

$\Sigma(Cem_n)(v_n) \leq \Sigma(Cem_{lim})(v_n)$

Where,

n = the total number of concrete mixtures for the project

Cem_n = the cement content for mixture n, kg/m^3 or lb/yd^3

Cem_{lim} = the maximum cement content for mixture n per Table 4.420.3, kg/m^3 or lb/yd^3

v_n = the volume of mixture n concrete to be placed, yd^3 or m^3

Calculations may use yd^3 or m^3 but must keep the same units throughout.

Embodied Carbon Limit Equation 4.420.3.5:

$\Sigma(EC_n)(v_n) \leq \Sigma(EC_{lim})(v_n)$

Where,

n = the total number of concrete mixtures for the project

EC_n = the embodied carbon content for mixture n, per mixture Environmental Product Declaration, $kgCO_2e/m^3$

EC_{lim} = the maximum embodied carbon content for mixture n per Table 4.420.3, $kgCO_2e/m^3$

v_n = the volume of mixture n concrete to be placed, yd^3 or m^3

LCC Compliance Form does the math for you!
Check your units!

Project Scenario #1

Project Scenario #1
A new 1,500 square foot home with a 5" thick slab and retaining wall that requires 23 cubic yards of concrete to be poured. This scenario assumes that a single mix with a compressive strength of up to 3,000 psi is needed.

Per Submitted EPD
- Portland Cement content = 400 lbs/yd^3
- Embodied carbon content = 230 kg CO_2/m^3

For 3000psi limits are:
- Portland Cement content = 410 lbs/yd^3
- Embodied carbon content = 289 kg CO_2/m^3

Cement Limit Check

Mix Cement Content: $\frac{400lbs}{yd^3} * 23\ yd^3 = 9{,}200\ lbs\ \ cement$

Mix Cement Limit: $\frac{410lbs}{yd^3} * 23\ yd^3 = 9{,}430\ lbs\ cement$ limit

9,200 lbs cement < 9,430 lbs cement limit - **Mix Complies**

Check your units!

Embodied Carbon Check

$Mix\ Embodied\ Carbon\ Content$: $\frac{230\ kg\ CO2}{m^3} * \frac{0.765\ m^3}{1\ yd^3} * 23\ yd^3 = 4{,}044\ kg\ C02$

$Mix\ Embodied\ Carbon\ Limit$: $\frac{289lbs}{yd^3} * \frac{0.765m^3}{1\ yd^3} * 23\ yd^3 =$ $5{,}082\ kg\ CO2\ maximum$

4,044 kg CO2 in mix < 5,082 kg CO2 maximum – **Mix Complies**

Project Scenario #2

Scenario # 2

Same scenario as scenario #1, requiring 23 cubic yards with a compressive strength of up to 3,000 psi. However, instead of low-carbon concrete mix, a more traditional concrete mix is used.

Per Submitted EPD:

- Portland Cement content = 564 lbs/yd^3
- Embodied carbon content = 400 kg CO_2/m^3

For 3000psi limits are:

- Portland Cement content = 410 lbs/yd^3
- Embodied carbon content = 289 kg CO_2/m^3

Cement Limit Check

Mix Cement Content: $\frac{564lbs}{yd^3} * 23\ yd^3 = 12{,}792\ lbs\ \ cement$

Mix Cement Limit: $\frac{410lbs}{yd^3} * 23\ yd^3 = 9{,}430\ lbs\ cement$ limit

12,792 lbs cement in mix > 9,430 lbs cement limit - Mix does not Comply

Embodied Carbon Check

$Mix\ Embodied\ Carbon\ Content$: $\frac{400\ kg\ CO2}{m^3} * \frac{0.765\ m^3}{1\ yd^3} * 23yd^3 =$

$7{,}034\ kg\ C02$

$Mix\ Embodied\ Carbon\ Limit$: $\frac{289lbs}{yd^3} * \frac{0.765m^3}{1\ yd^3} * 23\ yd^3 =$

$5{,}082\ kg\ CO2\ maximum$

7,034 kg CO_2 in mix > 5,082 kg CO_2 limit - Mix does not Comply

Project Scenario #3

Scenario #3

In this scenario assume the project requires three different mixes with compressive strengths of 2,500, 3,000 and 4000 psi.

Per EPDs:

- Mix #1. 6 cubic yards to be poured
  - Portland Cement content = 100 lbs/yd^3
  - Embodied carbon content = 230 kg CO_2/m^3
- Mix #2. 8 cubic yards to be poured
  - Portland Cement content = 400 lbs/yd^3
  - Embodied carbon content = 255 kg CO_2/m^3
- Mix #3. 9 cubic yards to be poured
  - Portland Cement content = 480 lbs/yd^3
  - Embodied carbon content = 320 kg CO_2/m^3

For 2500 psi limits are :

- Portland Cement content = 362 lbs/yd^3
- Embodied carbon content = 260 kg CO_2/m^3

For 3000 psi limits are :

- Portland Cement content = 410 lbs/yd^3
- Embodied carbon content = 289 kg CO_2/m^3

For 4000 psi limits are :

- Portland Cement content = 456 lbs/yd^3

Embodied carbon content = 313 kg CO_2/m^3

Project Scenario #3

Cement Limit Check

Mix	Quantity (yd3)	Cement Content (lbs /yd3)	Total Cement (lbs)	Cement Content Limit (lbs/ yd3)	Total Cement Limit (lbs)
1	6	100	**600**	362	**2,172**
2	8	400	**3,200**	410	**3,280**
3	9	480	**4,320**	456	**4,104**
Total	23	N/A	**8,120**	N/A	**9,556**

Mixes Comply

Embodied Carbon Check

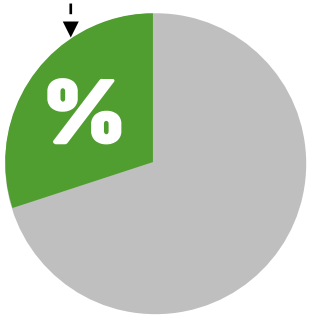
Mix	Quantity (m3)	Embodied Carbon Content (kg CO2 /m3)	Total Embodied Carbon (kg CO2)	Embodied Carbon Limit (kg CO2 /m3)	Total Embodied Carbon Limit (kg CO2
1	4.59	230	**1,056**	260	**1,193**
2	6.12	255	**1,561**	289	**1,769**
3	6.89	320	**2,205**	313	**2,157**
Total	17.6	N/A	**4,822**	N/A	**5,119**

Mixes Comply

Code Enforcement

If applicant does not meet the low carbon concrete standards:

The applicant can show **reduced equivalent carbon emissions** from the remaining portions of construction to demonstrate **alternative compliance**.*



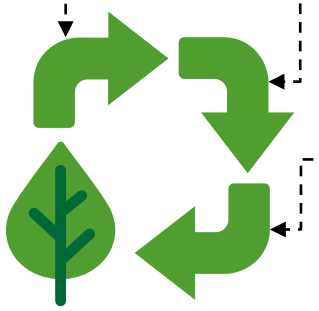
** Code is not prescriptive on how to show this.*

The applicant can look to **mid-cycle updates** for inspiration on potential pathways:

Building/ material reuse

Conduct Life Cycle Assessment for entire project

Show reduced embodied carbon in other building materials*



** Such as steel, glass, insulation, etc.*

While the Building Official can issue penalties for non-compliance:

The City intends to issue warnings and assist with compliance first.

LCC Code Enforcement

The maximum penalty, if issued, would be determined as follows:

Pm = (ECx)($190) + A

Where,

Pm = the maximum penalty ($)

ECx = the total excess embodied carbon content in the project, in metric tons.

$190 = penalty per metric ton of excess embodied carbon ($/metric ton)

A = Building and Safety Administrative Fee ($), refer to the City's Master Fee Schedule

Scenario 2 Mix resulted in 1.95 metric tons of excess CO_2. Assume the Building and Safety Division estimates that two (2) hours of staff time is needed for this project billed at $255/hr.

Maximum Penalty: $1.95\ metric\ tons\ CO_2 * \frac{\$190}{1\ metric\ ton\ CO_2} + \$510 = \$880.50$

Compliance Assistance Tools

- Example calculations, fact sheets, and compliance form will be available on City's website
- Designated program contact available to answer questions.

Next Steps & Questions

- Tentatively scheduled to go to City Council May 7, 2024
- If adopted, the code would be effective January 1, 2025

For More Information

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