NRMCA Concrete Carbon Calculator:

How to Reduce, Quantify, and Specify Carbon

- **Tiffany Reed-Villarreal, P.E.**
- Director, Sustainability Codes and Standards
- National Ready Mixed Concrete Assoc.

NRMCA

BUILD WITH STRENGTH

PAVE AHEAD
DURABLE. SUSTAINABLE. CONCRETE.



NRMCA Sustainability Initiatives

2009 | 2012 | 2014 | 2016 | 2021

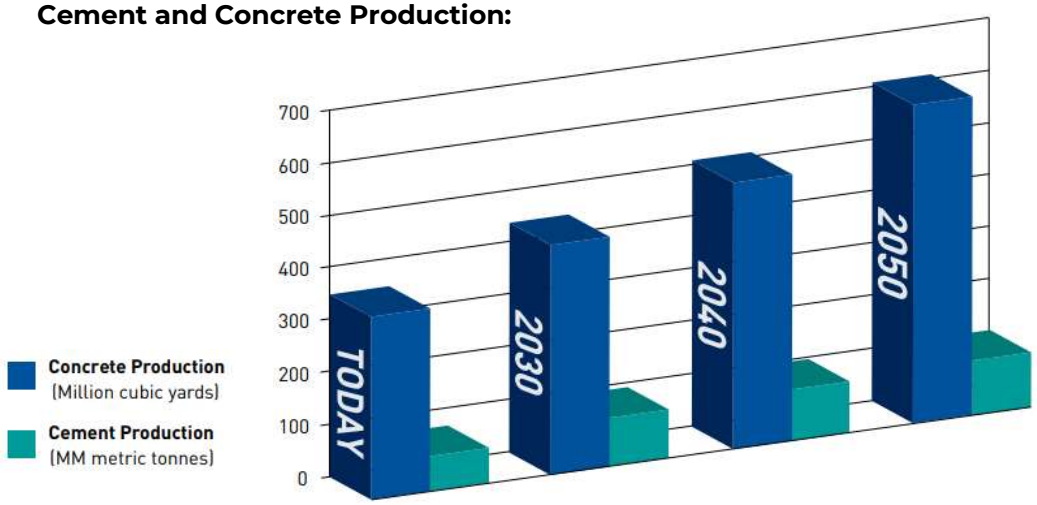
ADOPTER architecture 2030 CHALLENGE

NRMCA CERTIFIED EPD

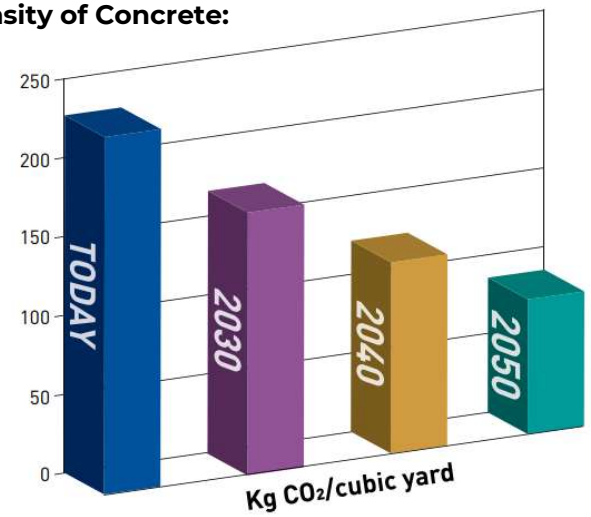
BUILD WITH STRENGTH

Roadmap to Carbon Neutrality
A more sustainable world is Shaped by Concrete

Cement and Concrete Production:

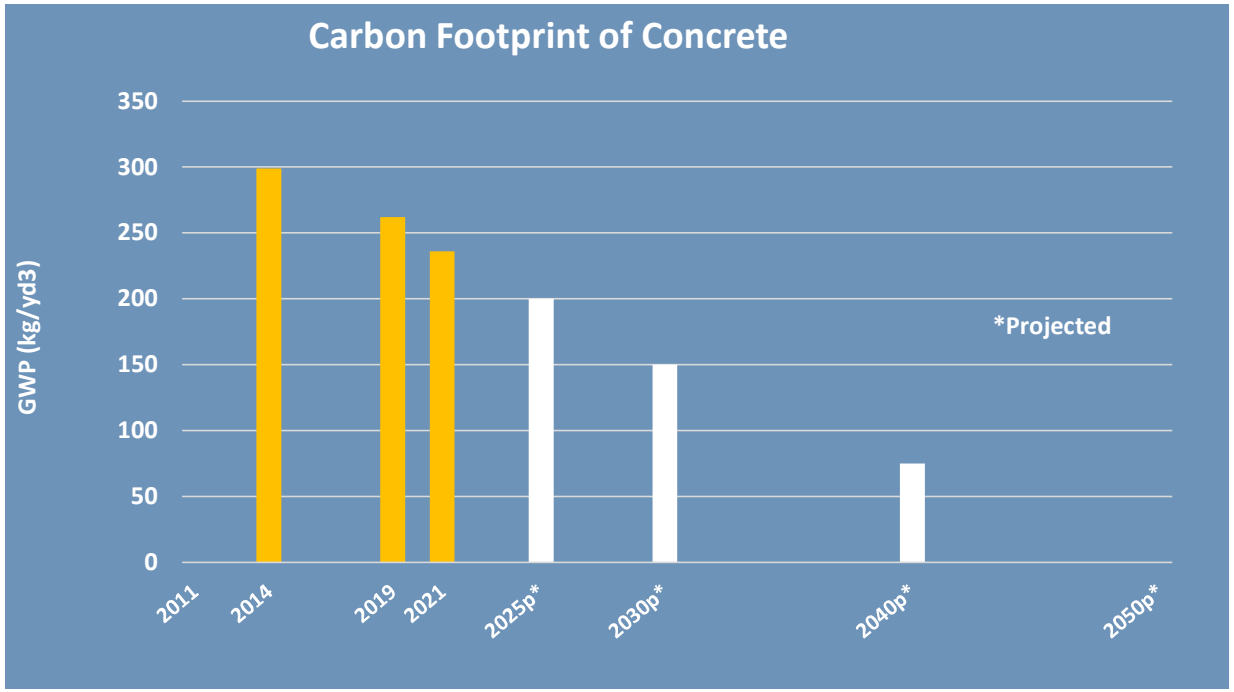


CO2 Intensity of Concrete:



Concrete Industry EPD Progress

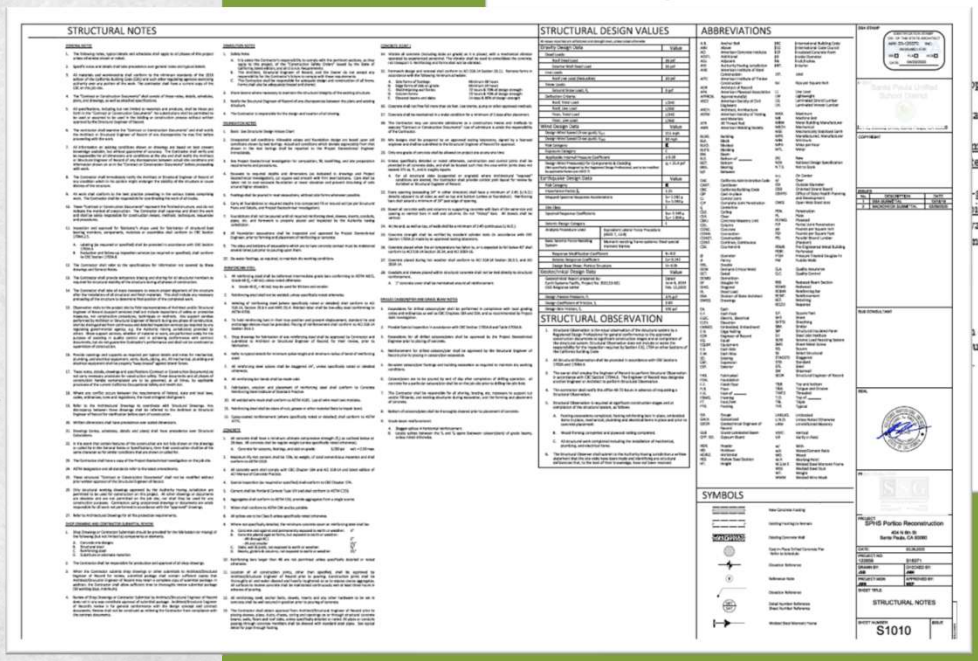
- **<u>2014 to 2021:</u>**
- 21% decrease in embodied CO_2
- **<u>Present Day:</u>**
- 90,000+ EPDs generated
  - All other construction materials combined:
    ~200+ EPDs

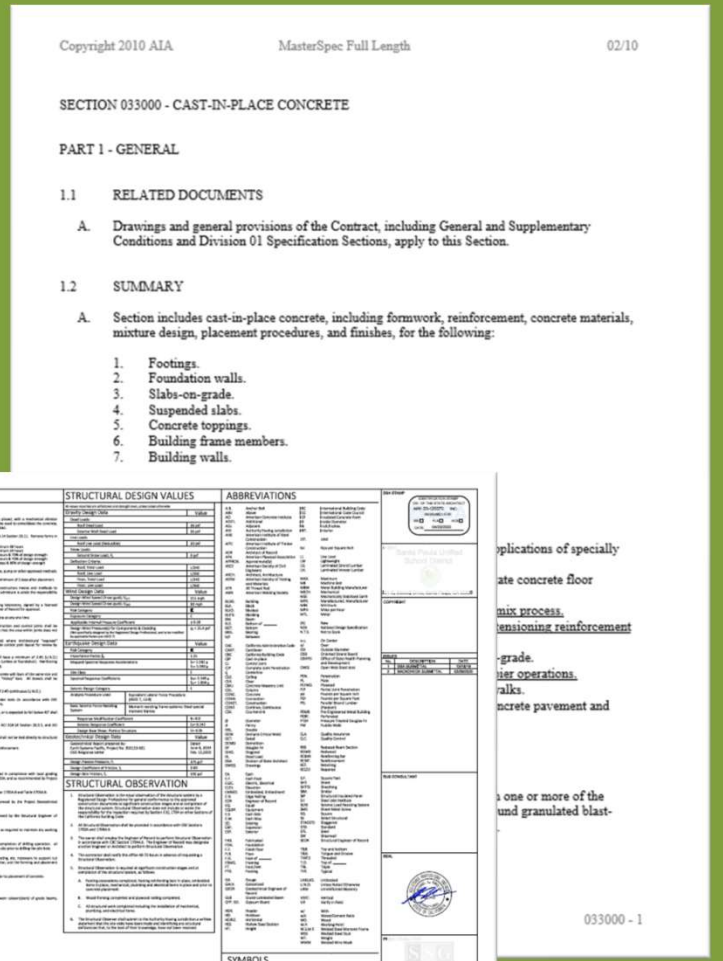


Division 03
Section 033000
Cast-In-Place Concrete

- **Step #1:**
- Performance-Based Improvements

- **Step #2:**
- Carbon Accounting and Targets





Step #1 – Performance Based Improvements

- **Goal:**
- Prescription → Performance

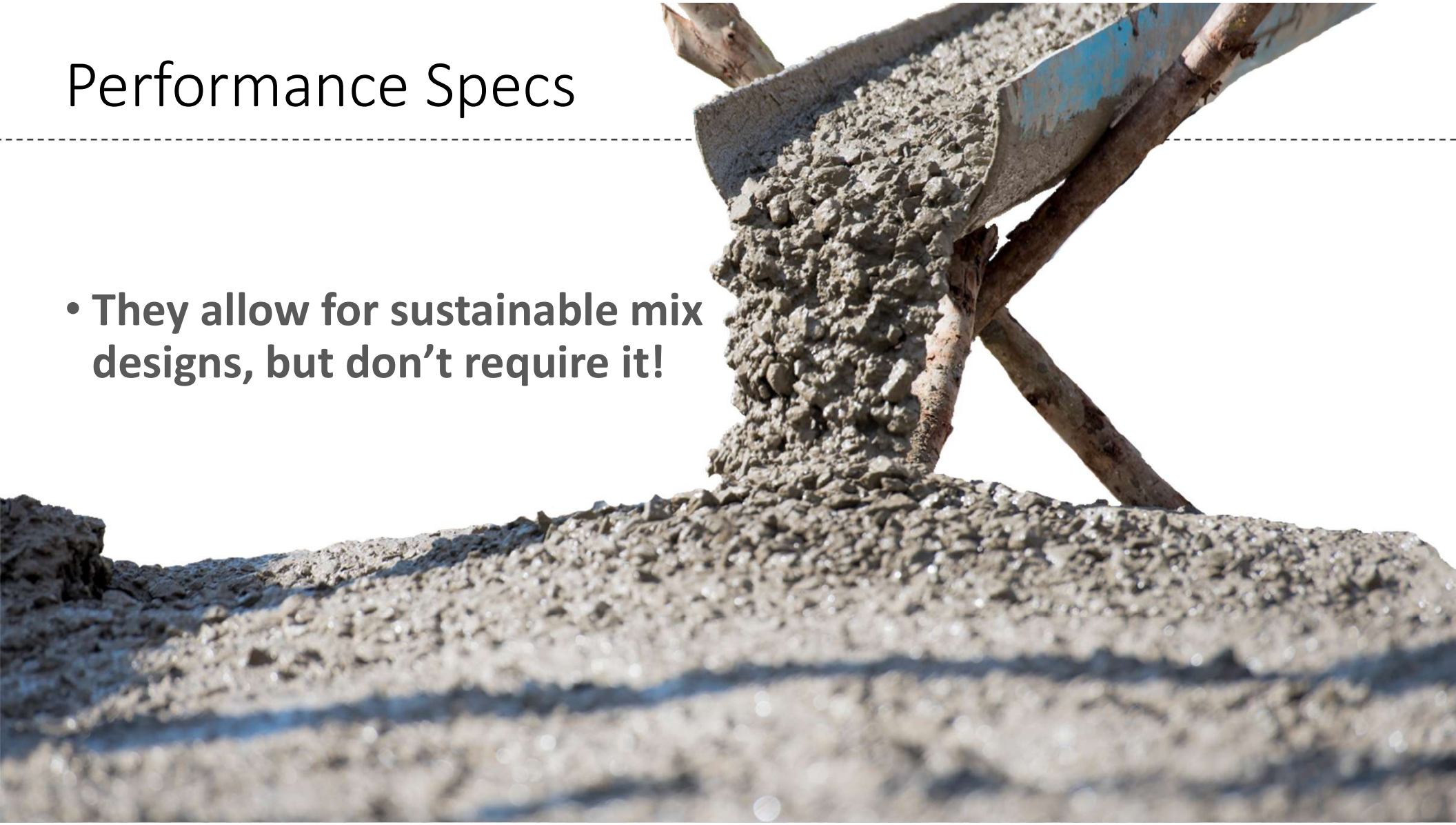
- **Methods:**
  - ➢ Emphasize ACI 318 Exposure Classes
  - ➢ Alt testing for durability/design
    - Shrinkage, MOE, RCP, ASR
  - ➢ Expand acceptable materials
  - ➢ Extended strength development

- **Results:**
- Efficient and Optimized Mix Designs



Performance Specs

- **They allow for sustainable mix designs, but don’t require it!**



Step #2 – Carbon Accounting and Targets

- **Goal:**
- Trigger the use of low carbon materials

- **Methods:**
  - ➢ Collect EPDs
  - ➢ Establish a Carbon Budget

- **Results:**
  - ➢ Procurement of low carbon concrete
  - ➢ Flexibility for the contractor and producer
  - ➢ Buffer for as-built conditions



Specifications for Sustainability

Member	Mix ID	Durability Exposure				Specified Strength, f'_c, psi	Max w/cm or Performance Alternative	Nom. max Aggregate, in.	Air Content	Slump/ Slump Flow	Chloride Limit	Temp. Limits	Max. GWP (kg/yd3 CO_2e)
		F	S	W	C								
Footings													250
Foundation Walls													250
Slabs-on-grade													250
Exterior slabs													3[illegible]
Suspended slabs (interior)													3[illegible]0
Suspended slabs (exterior)													3[illegible]0
Frame members													[illegible]00
Columns (interior)													300
Columns (exterior)													300
Walls (interior)													250
Concrete toppings													250

- Collaborative carbon budget **vs.** GWP limit per mix class
- **Preferred**

Specifications for Sustainability

Project Budget

TOTAL GWP: 4.30 x 10^6



VS

Individual Mix Limits

TOTAL GWP: 4.30 x 10^6

Shear Walls:
180 kg CO_2 eq/m^3

Columns:
190 kg CO_2 eq/m^3

Floors 2-18:
240 kg CO_2 eq/m^3

Floors B2-1:
225 kg CO_2 eq/m^3

Basement Walls:
190 kg CO_2 eq/m^3

Foundation:
175 kg CO_2 eq/m^3

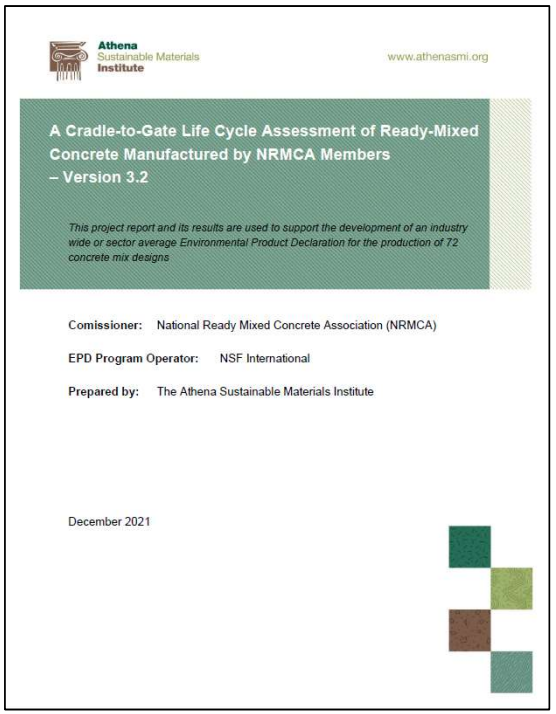


Establishing a Carbon Budget

Structural Takeoff

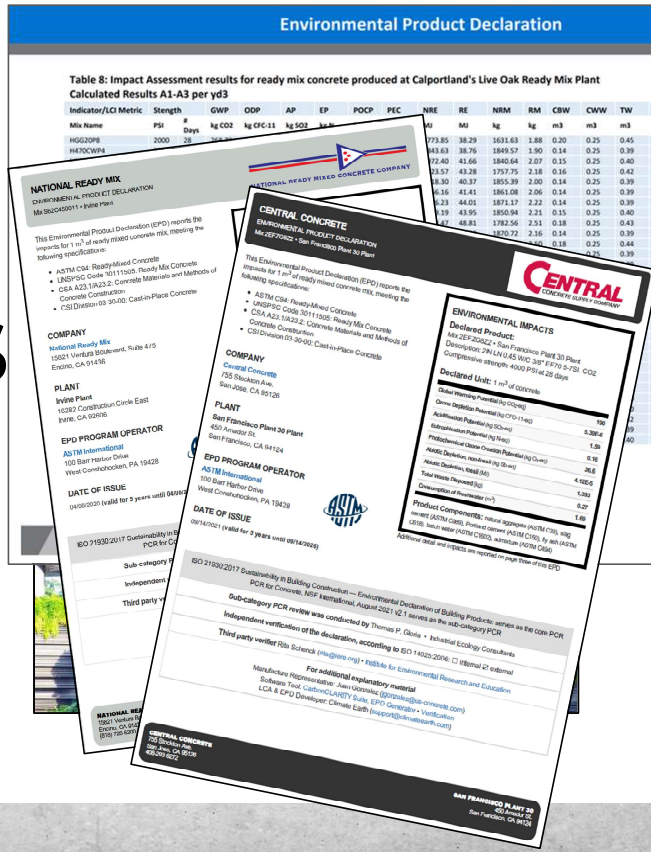


Benchmark Project



VS

Proposed Project



Life Cycle Analysis:

Shear Walls: (yd^3) x (GWP) = Impact

Columns: (yd^3) x (GWP) = Impact

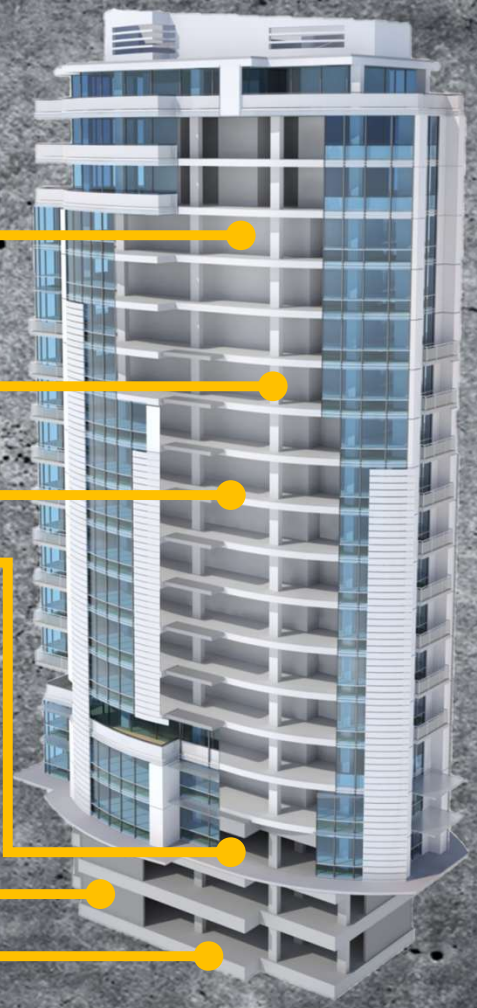
Floors 2-18: (yd^3) x (GWP) = Impact

Floors B2-1: (yd^3) x (GWP) = Impact

Basement Walls: (yd^3) x (GWP) = Impact

Mat Foundation: (yd^3) x (GWP) = Impact

TOTAL: Project Impact



Example Project

- **Structure:**
  18-Story
  Residential Tower
- **Location:**
  Boston, MA
- **Concrete:**
  6 Primary Classes
- **Material:**
  Fly Ash and Slag Available

Shear Walls: (yd^3) x (GWP) = Impact

Columns: (yd^3) x (GWP) = Impact

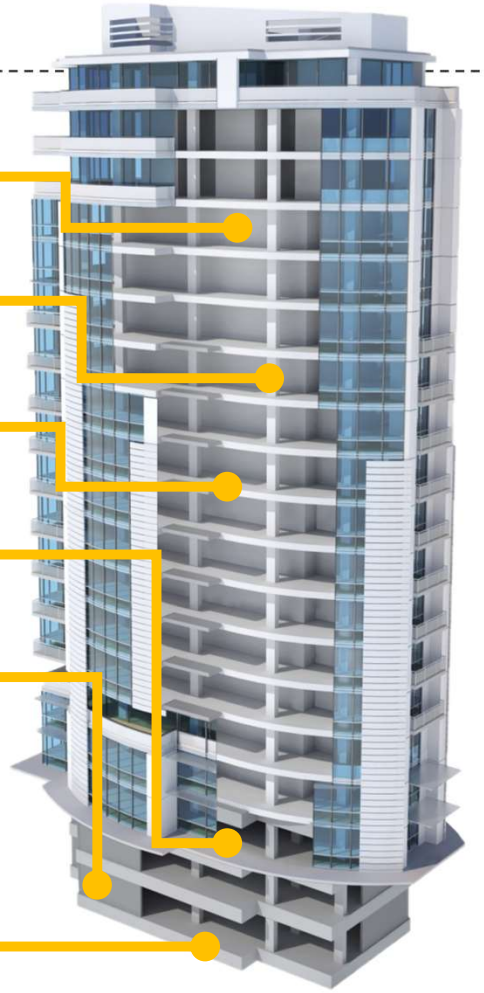
Floors 2-18: (yd^3) x (GWP) = Impact

Floors B2-1: (yd^3) x (GWP) = Impact

Basement Walls: (yd^3) x (GWP) = Impact

Mat Foundation: (yd^3) x (GWP) = Impact

TOTAL: Project Impact

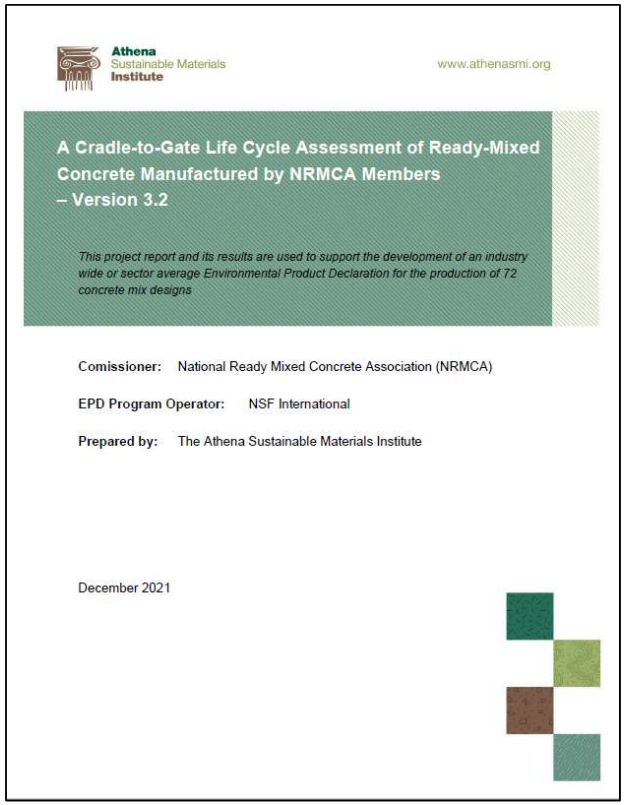


Estimating Quantities and Properties

Concrete Element	Concrete Volume (yd^3)	Benchmark Mixes (benchmark)*	Proposed Mixes (IW-EPD)*
Shear Walls	**7,630**	**6,000 psi**	**6,000 psi** 30% slag, 20% fly ash
Columns	**366**	**8,000 psi**	**8,000 psi** 40% fly ash
Floors 2-18	**4,533**	**5,000 psi**	**5,000 psi** 30% slag
Floors B2-1	**1,067**	**5,000 psi**	**5,000 psi** 40% fly ash
Basement Walls	**444**	**5,000 psi**	**5,000 psi** 30% slag, 20% fly ash
Foundation	**3,844**	**6,000 psi**	**6,000 psi** 40% slag, 30% fly ash

*Should be augmented with local data, knowledge, capabilities

NRMCA Benchmark Mixes



Athena Sustainable Materials Institute www.athenasmi.org

A Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufactured by NRMCA Members – Version 3.2

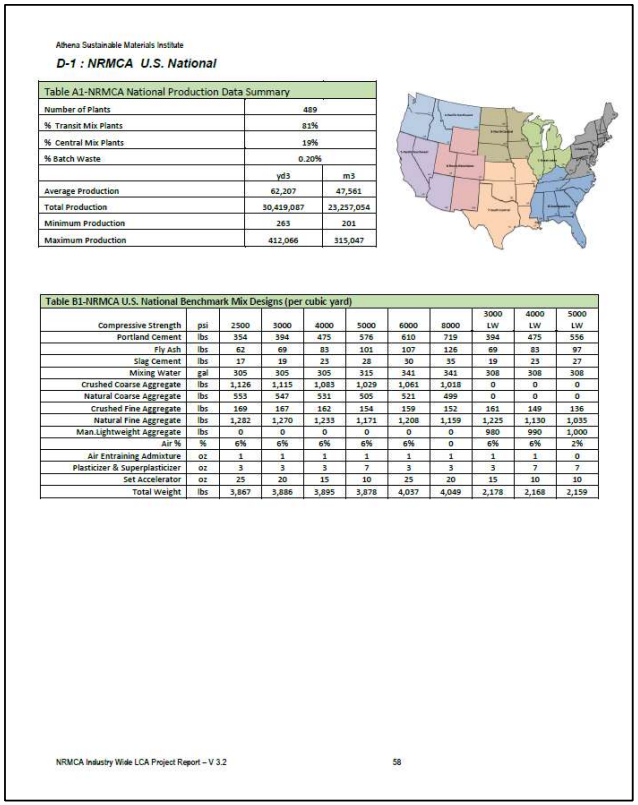
This project report and its results are used to support the development of an industry wide or sector average Environmental Product Declaration for the production of 72 concrete mix designs

Comissioner: National Ready Mixed Concrete Association (NRMCA)

EPD Program Operator: NSF International

Prepared by: The Athena Sustainable Materials Institute

December 2021



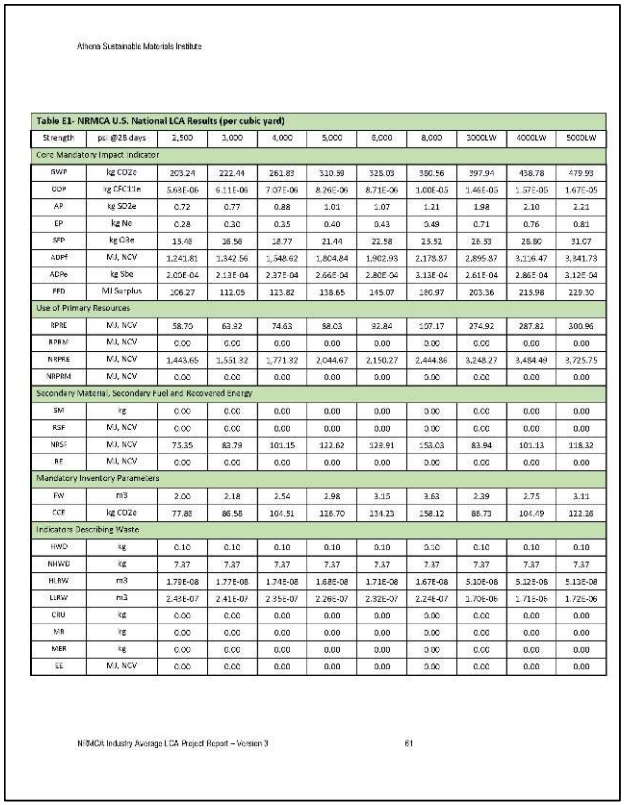
Athena Sustainable Materials Institute

D-1 : NRMCA U.S. National

Table A1-NRMCA National Production Data Summary		
Number of Plants	489	
% Transit Mix Plants	81%	
% Central Mix Plants	19%	
% Batch Waste	0.20%	
	yd3	m3
Average Production	62,207	47,561
Total Production	30,419,087	23,257,054
Minimum Production	263	201
Maximum Production	412,066	315,047

Table B1-NRMCA U.S. National Benchmark Mix Designs (per cubic yard)										
Compressive Strength	psi	2500	3000	4000	5000	6000	8000	3000 LW	4000 LW	5000 LW
Portland Cement	lbs	354	394	475	576	610	719	394	475	556
Fly Ash	lbs	62	69	83	101	107	126	69	83	97
Slag Cement	lbs	17	19	23	28	30	35	19	23	27
Mixing Water	gal	305	305	305	315	341	341	308	308	308
Crushed Coarse Aggregate	lbs	1,126	1,115	1,083	1,029	1,061	1,018	0	0	0
Natural Coarse Aggregate	lbs	553	547	531	505	521	499	0	0	0
Crushed Fine Aggregate	lbs	169	167	162	154	159	152	161	149	136
Natural Fine Aggregate	lbs	1,282	1,270	1,233	1,171	1,208	1,159	1,225	1,130	1,035
Man.Lightweight Aggregate	lbs	0	0	0	0	0	0	980	990	1,000
Air %	%	6%	6%	6%	6%	6%	0	6%	6%	2%
Air Entraining Admixture	oz	1	1	1	1	1	1	1	1	0
Plasticizer & Superplasticizer	oz	3	3	3	7	3	3	3	7	7
Set-Accelerator	oz	25	20	15	10	25	20	15	10	10
Total Weight	lbs	3,867	3,886	3,895	3,878	4,037	4,049	2,178	2,168	2,159

NRMCA Industry Wide LCA Project Report – V 3.2 58



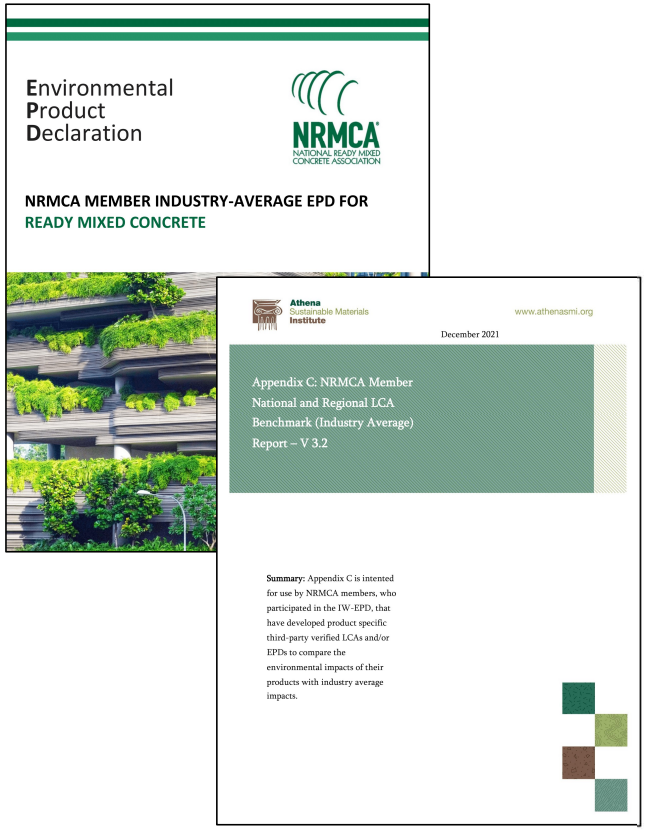
Athena Sustainable Materials Institute

Table E1- NRMCA U.S. National LCA Results (per cubic yard)										
Strength	psi @28 days	2,500	3,000	4,000	5,000	6,000	8,000	3000LW	4000LW	5000LW
Core Mandatory Impact Indicator										
GWP	kg CO2e	203.24	222.44	261.83	310.99	328.09	380.56	397.94	458.78	479.99
ODP	kg CFC11e	5.69E-06	6.11E-06	7.07E-06	8.26E-06	8.71E-06	1.00E-05	1.46E-05	1.57E-05	1.67E-05
AP	kg SO2e	0.72	0.77	0.88	1.01	1.07	1.21	1.98	2.10	2.21
EP	kg Ne	0.28	0.30	0.35	0.40	0.43	0.49	0.71	0.76	0.81
SFP	kg O3e	15.48	16.56	18.77	21.44	22.58	25.51	28.33	25.90	31.07
ADPf	MJ, NCV	1,241.81	1,342.56	1,548.62	1,804.84	1,902.93	2,178.87	2,895.87	3,106.47	3,341.73
ADPe	kg Sbe	2.05E-04	2.13E-04	2.37E-04	2.66E-04	2.80E-04	3.13E-04	2.61E-04	2.86E-04	3.12E-04
PED	MJ Surplus	106.27	112.05	123.82	138.65	145.07	160.97	203.36	213.98	229.30
Use of Primary Resources										
RPRE	MJ, NCV	58.75	63.32	74.63	88.03	92.84	107.17	274.92	287.82	300.96
RPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRPRE	MJ, NCV	1,443.65	1,551.32	1,771.32	2,044.67	2,150.27	2,444.86	3,248.27	3,484.49	3,725.75
NRPRM	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy										
SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	MJ, NCV	75.35	83.79	101.15	122.62	128.91	153.03	83.94	101.13	118.32
RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters										
FW	m3	2.00	2.18	2.54	2.98	3.15	3.63	2.39	2.75	3.11
CCE	kg CO2e	77.88	86.58	104.51	116.70	134.23	158.12	88.73	104.09	122.26
Indicators Describing Waste										
HWD	kg	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NHWD	kg	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37	7.37
HLRW	m3	1.73E-08	1.77E-08	1.74E-08	1.68E-08	1.71E-08	1.67E-08	5.10E-08	5.12E-08	5.13E-08
LLRW	m3	2.43E-07	2.41E-07	2.35E-07	2.28E-07	2.32E-07	2.24E-07	1.70E-06	1.71E-06	1.72E-06
CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

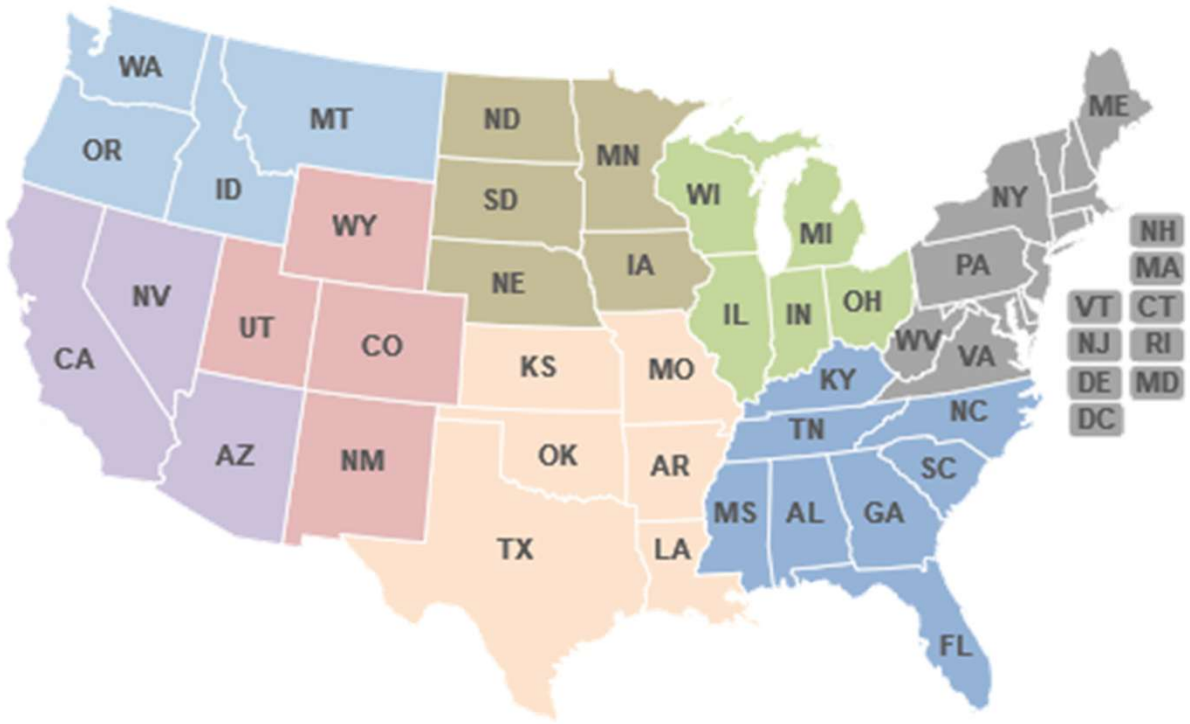
NRMCA Industry Average LCA Project Report – Version 3 61

Download at **https://www.nrmca.org/sustainability**

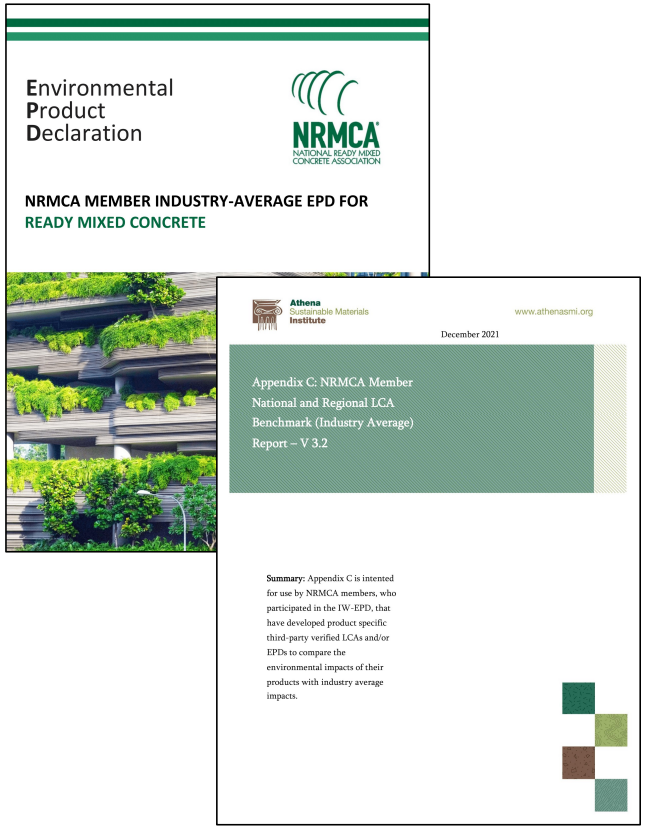
NRMCA Benchmarks - Regions



2021 Version 3



NRMCA Benchmarks - Regions





NRMCA Benchmark Mixes

Shear Walls	7,630	6,000 psi	6,000 psi 30% slag, 20% fly ash

Results Table E2-Eastern LCA Results (per cubic yard)										
Strength	psi @28 days	2,500	3,000	4,000	5,000	6,000	8,000	3000LW	4000LW	5000LW
Core Mandatory Impact Indicator										
GWP	kg CO2e	183.29	201.48	240.22	289.03	305.26	360.51	395.35	437.90	480.10
ODP	kg CFC11e	5.91E-06	6.36E-06	7.32E-06	8.52E-06	8.96E-06	1.03E-05	1.47E-05	1.58E-05	1.69E-05
AP	kg SO2e	0.67	0.71	0.81	0.93	0.98	1.12	2.10	2.22	2.33
EP	kg Ne	0.24	0.26	0.30	0.36	0.37	0.44	0.69	0.74	0.79
SFP	kg O3e	14.31	15.21	17.18	19.61	20.57	23.34	29.65	31.81	33.89
ADPf	MJ, NCV	400.61	412.16	442.07	482.50	503.70	548.75	2,225.23	2,290.96	2,344.41
ADPe	kg Sbe	1.28E-04	1.30E-04	1.36E-04	1.42E-04	1.48E-04	1.55E-04	1.71E-04	1.79E-04	1.87E-04

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Identifying Global Warming Potential

Concrete Element	Concrete Volume (yd^3)	Benchmark Mixes GWP (Eastern Region)*	Proposed Mixes GWP (IW-EPD)
Shear Walls	**7,630**	6,000 psi **305**	
Columns	**366**	8,000 psi **361**	
Floors 2-18	**4,533**	5,000 psi **289**	
Floors B2-1	**1,067**	5,000 psi **289**	
Basement Walls	**444**	5,000 psi **289**	
Foundation	**3,844**	6,000 psi **305**	

* Note: Pay attention to units as the report has GWP listed per yd^3 and per m^3

Environmental Product Declaration (EPD)

3rd party verified & registered documents that communicate transparency

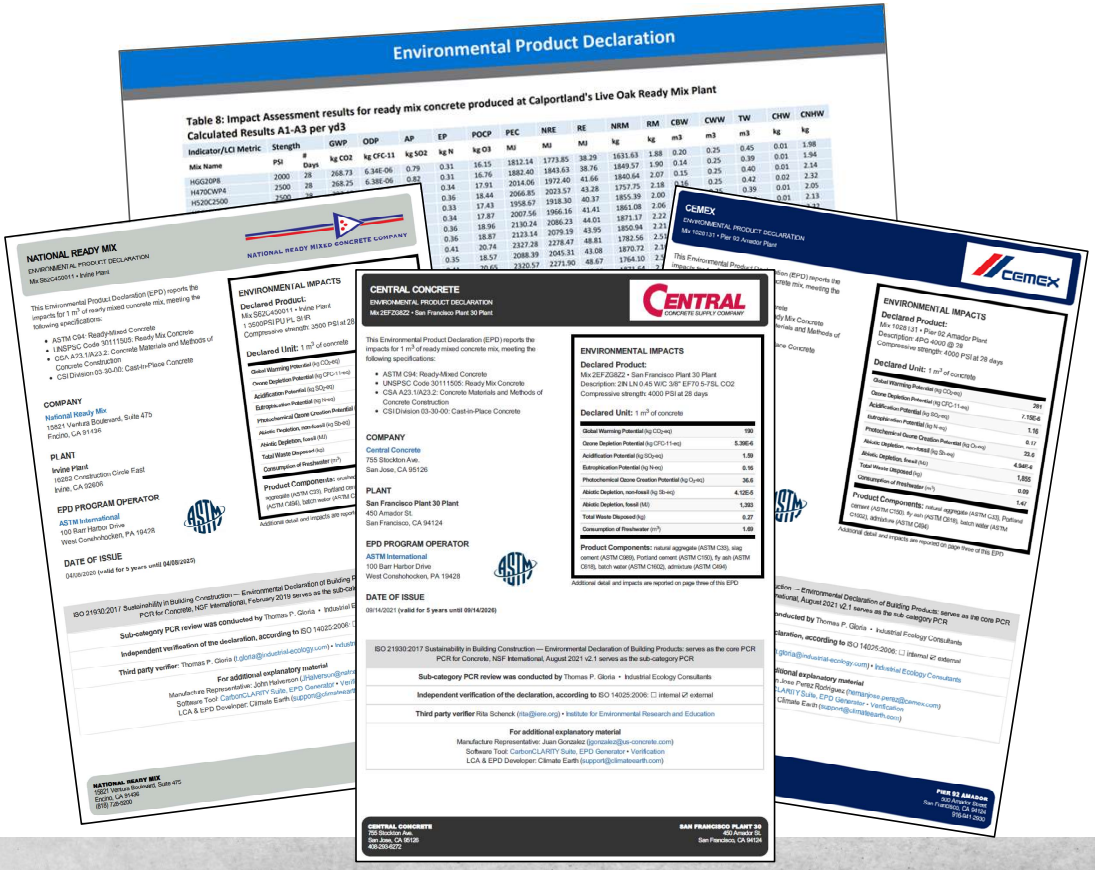
ENVIRONMENTAL IMPACTS

Declared Product:
Mix 2EFZG8Z2 • San Francisco Plant 30 Plant
Description: 2IN LN 0.45 W/C 3/8" EF70 5-7SL CO2
Compressive strength: 4000 PSI at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	190
Ozone Depletion Potential (kg CFC-11-eq)	5.39E-6
Acidification Potential (kg SO_2-eq)	1.59
Eutrophication Potential (kg N-eq)	0.16
Photochemical Ozone Creation Potential (kg O_3-eq)	36.6
Abiotic Depletion, non-fossil (kg Sb-eq)	4.12E-5
Abiotic Depletion, fossil (MJ)	1,393
Total Waste Disposed (kg)	0.27
Consumption of Freshwater (m^3)	1.69

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



NRMCA Proposed Industry Wide EPD Mixes

Shear Walls	7,630	6,000 psi	**6,000 psi** 30% slag, 20% fly ash

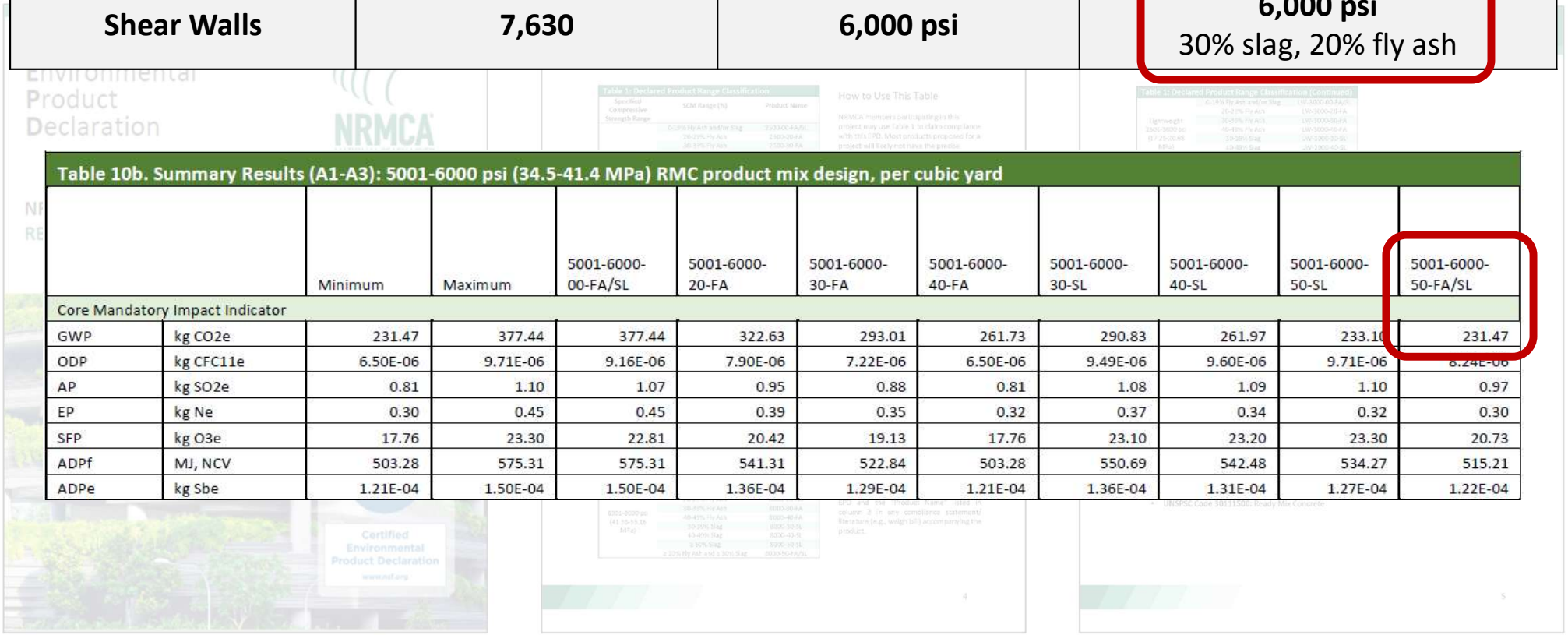


Table 10b. Summary Results (A1-A3): 5001-6000 psi (34.5-41.4 MPa) RMC product mix design, per cubic yard

		Minimum	Maximum	5001-6000-00-FA/SL	5001-6000-20-FA	5001-6000-30-FA	5001-6000-40-FA	5001-6000-30-SL	5001-6000-40-SL	5001-6000-50-SL	5001-6000-50-FA/SL
Core Mandatory Impact Indicator											
GWP	kg CO2e	231.47	377.44	377.44	322.63	293.01	261.73	290.83	261.97	233.10	231.47
ODP	kg CFC11e	6.50E-06	9.71E-06	9.16E-06	7.90E-06	7.22E-06	6.50E-06	9.49E-06	9.60E-06	9.71E-06	8.24E-06
AP	kg SO2e	0.81	1.10	1.07	0.95	0.88	0.81	1.08	1.09	1.10	0.97
EP	kg Ne	0.30	0.45	0.45	0.39	0.35	0.32	0.37	0.34	0.32	0.30
SFP	kg O3e	17.76	23.30	22.81	20.42	19.13	17.76	23.10	23.20	23.30	20.73
ADPf	MJ, NCV	503.28	575.31	575.31	541.31	522.84	503.28	550.69	542.48	534.27	515.21
ADPe	kg Sbe	1.21E-04	1.50E-04	1.50E-04	1.36E-04	1.29E-04	1.21E-04	1.36E-04	1.31E-04	1.27E-04	1.22E-04

Download at https://www.nrmca.org/sustainability

Identifying Global Warming Potential

Concrete Element	Concrete Volume (yd^3)	Benchmark Mixes GWP (Eastern Region)	Proposed Mixes GWP (IW-EPD)*
Shear Walls	**7,630**	**305**	**232** 30% slag, 20% fly ash
Columns	**366**	**361**	**303** 40% fly ash
Floors 2-18	**4,533**	**289**	**277** 30% slag
Floors B2-1	**1,067**	**289**	**249** 40% fly ash
Basement Walls	**444**	**289**	**220** 30% slag, 20% fly ash
Foundation	**3,844**	**305**	**166*** 40% slag, 30% fly ash

*Should be augmented with local data, knowledge, capabilities

Identifying Global Warming Potential

Concrete Element	Concrete Volume (yd^3)	Benchmark Mixes GWP (Eastern Region)	Proposed Mixes GWP (IW-EPD)*
Shear Walls	**7,630**	6,000 psi **305**	30% slag, 20% fly ash **232**
Columns	**366**	8,000 psi **361**	40% fly ash **303**
Floors 2-18	**4,533**	5,000 psi **289**	30% slag **277**
Floors B2-1	**1,067**	5,000 psi **289**	40% fly ash **249**
Basement Walls	**444**	5,000 psi **289**	30% slag, 20% fly ash **220**
Foundation	**3,844**	6,000 psi **305**	40% slag, 30% fly ash **166****

* Should be augmented with local data, knowledge, capabilities

** Use NRMCA Tool to input mix proportions which uses Life Cycle Inventory (LCI) data to estimate impact

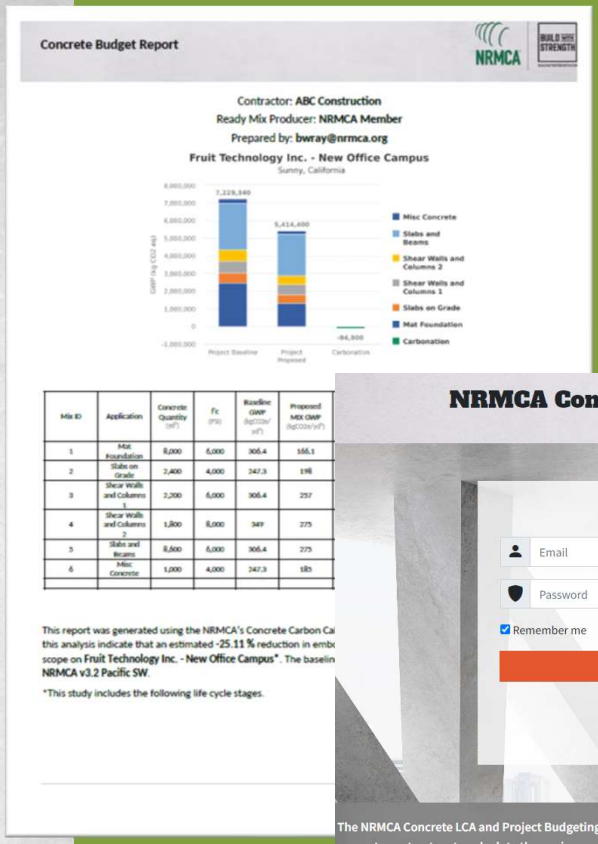
NRMCA Concrete Carbon Calculator

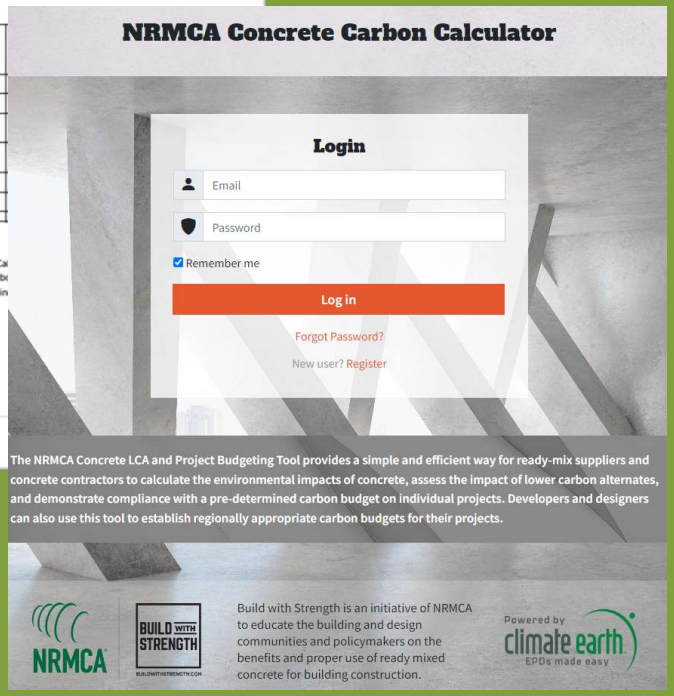
Producer

NRMCA

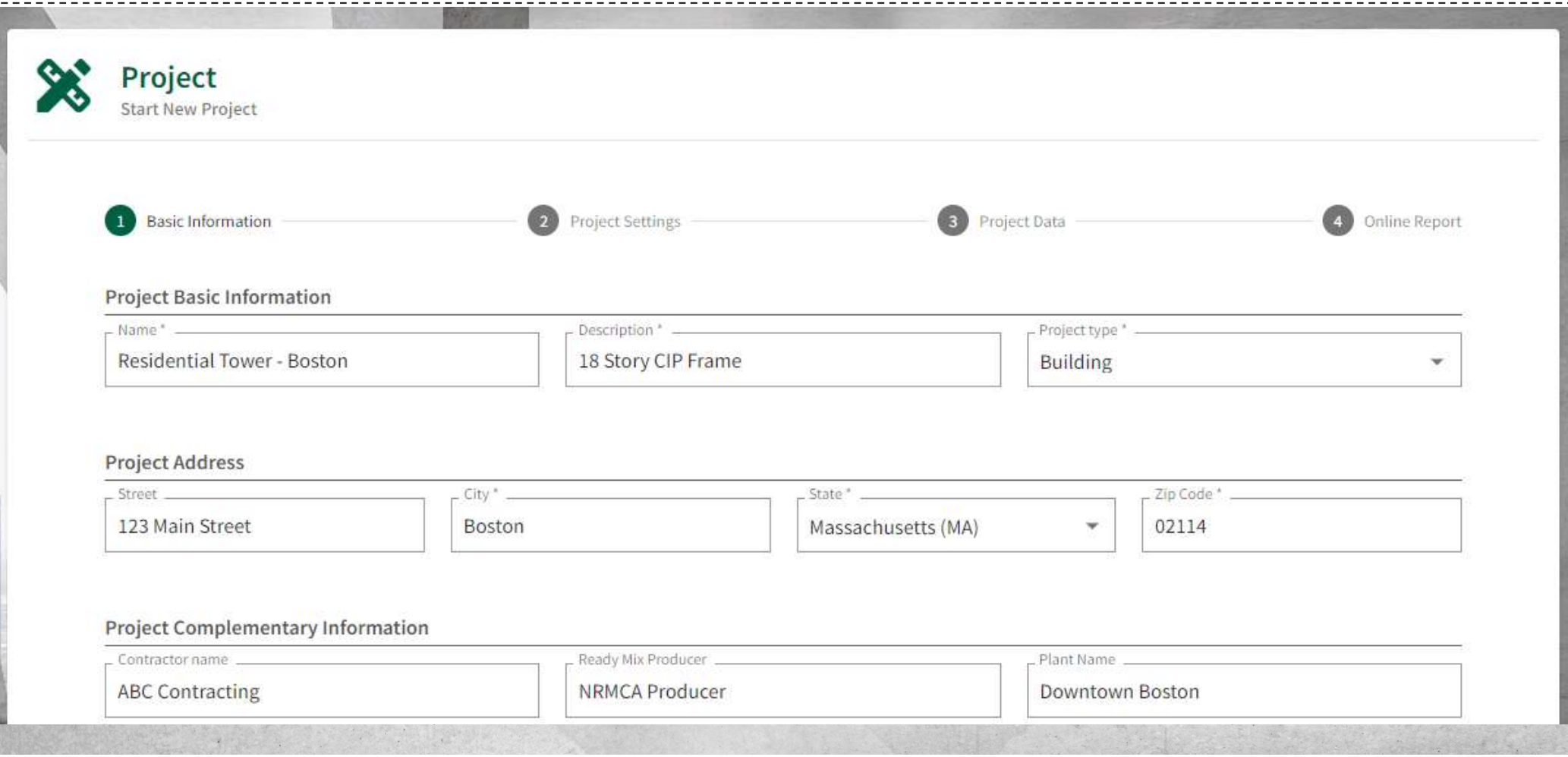
Designer

Access at **https://nrmca.climateearth.com/**

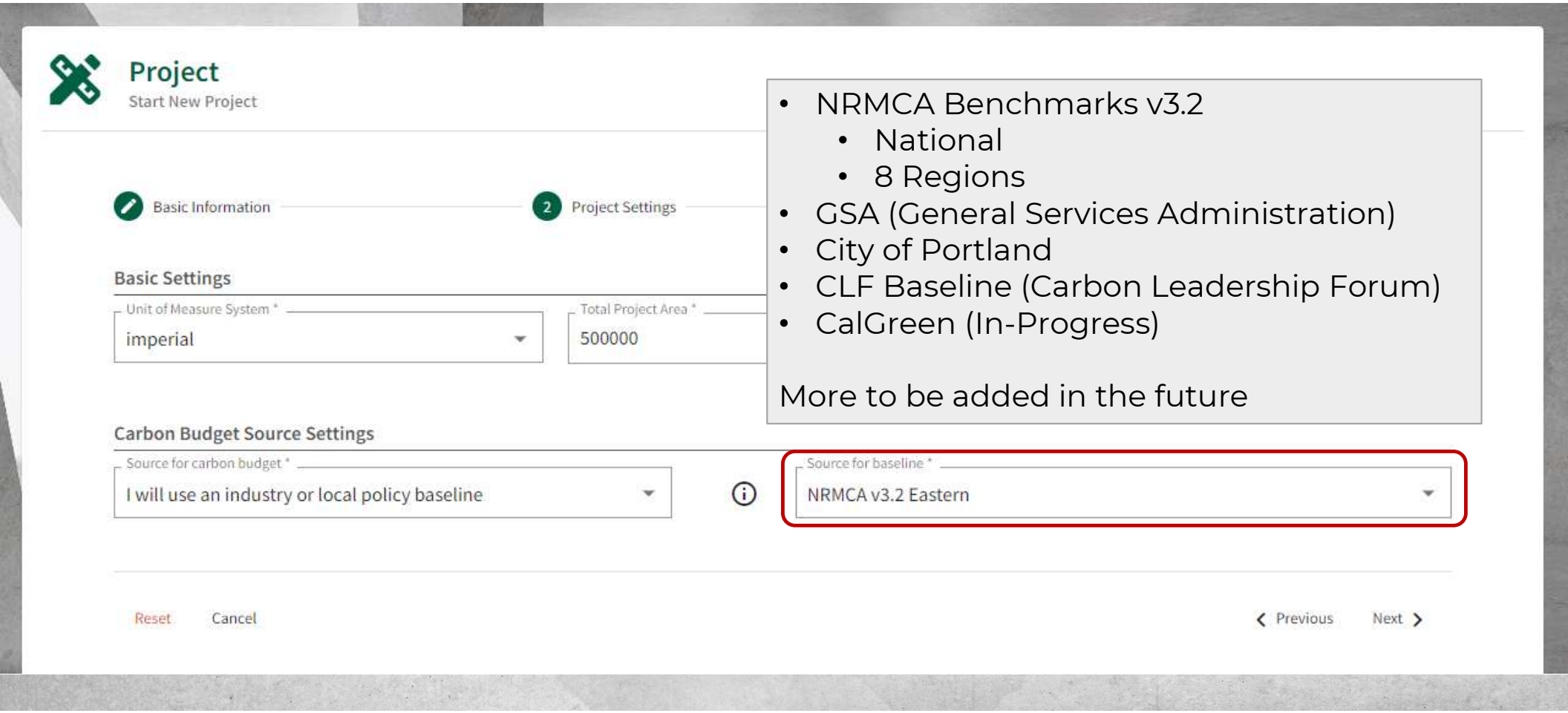




NRMCA Carbon Tool



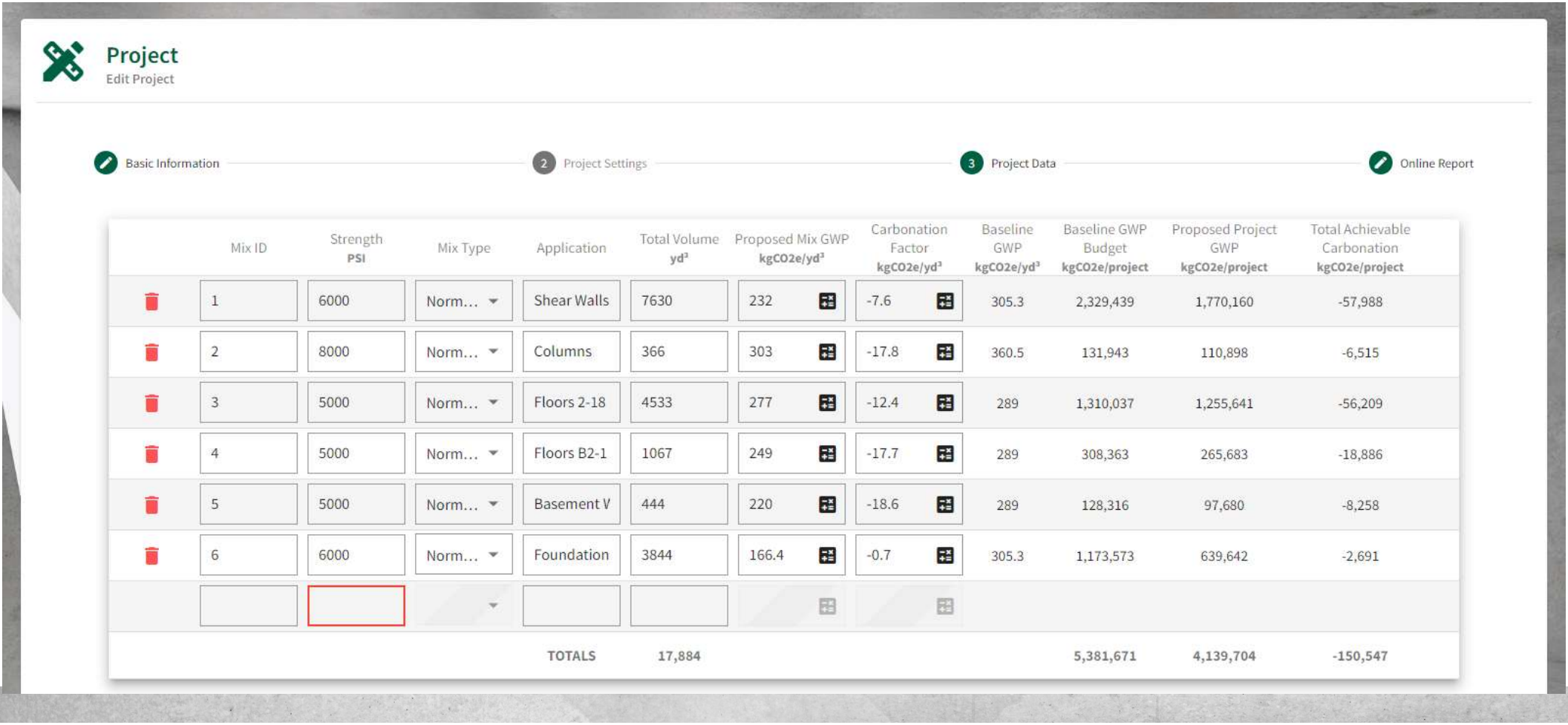
NRMCA Carbon Tool



- NRMCA Benchmarks v3.2
  - National
  - 8 Regions
- GSA (General Services Administration)
- City of Portland
- CLF Baseline (Carbon Leadership Forum)
- CalGreen (In-Progress)

More to be added in the future

NRMCA Carbon Tool



Project
Edit Project

Basic Information — 2 Project Settings — 3 Project Data — Online Report

	Mix ID	Strength PSI	Mix Type	Application	Total Volume yd³	Proposed Mix GWP kgCO2e/yd³	Carbonation Factor kgCO2e/yd³	Baseline GWP kgCO2e/yd³	Baseline GWP Budget kgCO2e/project	Proposed Project GWP kgCO2e/project	Total Achievable Carbonation kgCO2e/project
	1	6000	Norm…	Shear Walls	7630	232	-7.6	305.3	2,329,439	1,770,160	-57,988
	2	8000	Norm…	Columns	366	303	-17.8	360.5	131,943	110,898	-6,515
	3	5000	Norm…	Floors 2-18	4533	277	-12.4	289	1,310,037	1,255,641	-56,209
	4	5000	Norm…	Floors B2-1	1067	249	-17.7	289	308,363	265,683	-18,886
	5	5000	Norm…	Basement V	444	220	-18.6	289	128,316	97,680	-8,258
	6	6000	Norm…	Foundation	3844	166.4	-0.7	305.3	1,173,573	639,642	-2,691
				TOTALS	17,884				5,381,671	4,139,704	-150,547

NRMCA Carbon Tool

For calculating impact of a proposed 70% SCM replacement in foundations

2 Project Settings — 3 Project D

Application	Total Volume yd³	Proposed Mix GWP kgCO2e/yd³	Carbonation Factor kgCO2e/yd³	Baseline GWP kgCO2e/yd³
Shear Walls	7630	232	-7.6	305.3
Columns	366	303	-17.8	360.5
Floors 2-18	4533	277	-12.4	289
Floors B2-1	1067	249	-17.7	289
Basement V	444	220	-18.6	289
Foundation	3844	166.4	-0.7	305.3
TOTALS	17,884			

Proposed Mix GWP for 'Mat Foundation'

Important information

This result is NOT an EPD. This GWP was calculated using the same LCI data sources as prescribed in Table A1 of the PCR for Concrete, NSF International, August 2021 v2.1. A3 is assumed to be 9.04 kg CO2eq/m3 per NRMCA's Benchmark Report v3.2. This GWP is strictly an estimate and is based on industry averages, regional data, and average transportation impacts and should be used for estimation purposes only. For more accurate results, it is recommended that a Type III Third-Party Verified Product Specific EPD be developed.

For a more accurate plant specific estimate, use your EPD tool provider's EPD estimator.

Material	Quantity per yd³	UoM
Batch Water	32	GAL
Portland Limestone Cement (Type IL)/ASTM C595 - Domestic	282	LB
Fly Ash	112	LB
Slag Cement/ASTM C989 - Imported	170	LB
Crushed Coarse Aggregate/ Crushed Fine Aggregate	1650	LB
Natural Fine Aggregate	1350	LB
Plasticizer and Superplasticizer	24	FL.OZ

Cancel Download Mix Design File Calculate

NRMCA Carbon Tool

For calculating the carbonation potential of each element.

ings — 3 Project Data — Online Report

Total Volume yd³	Proposed Mix GWP kgCO2e/yd³	Carbonation Factor kgCO2e/yd³	Baseline GWP kgCO2e/yd³	Baseline GWP Budget kgCO2e/project	Proposed Project GWP kgCO2e/project	Total Achievable Carbonation kgCO2e/project
7630	232	-7.6	305.3	2,329,439	1,770,160	-57,988
366	303	-17.8	360.5	131,943	110,898	-6,515
4533	277	-12.4	289	1,310,037	1,255,641	-56,209
1067	249	-17.7	289	308,363	265,683	-18,886
444	220	-18.6	289	128,316	97,680	-8,258
3844	166.4	-0.7	305.3	1,173,573	639,642	-2,691
17,884				5,381,671	4,139,704	-150,547

Carbonation Factor

Use type *

Reference Service Life (RSL) (years) *

Exposed surface (yd^2/yd^3) *

Exposure category *

Cement content (lb/yd^3) *

Percent clinker in cement (%) *

Percent limestone in concrete (%) *

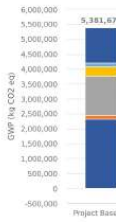
Percent silica fume in concrete (%) *

Percent fly ash in concrete (%) *

Cancel Calculate

NRMCA Carbon Tool

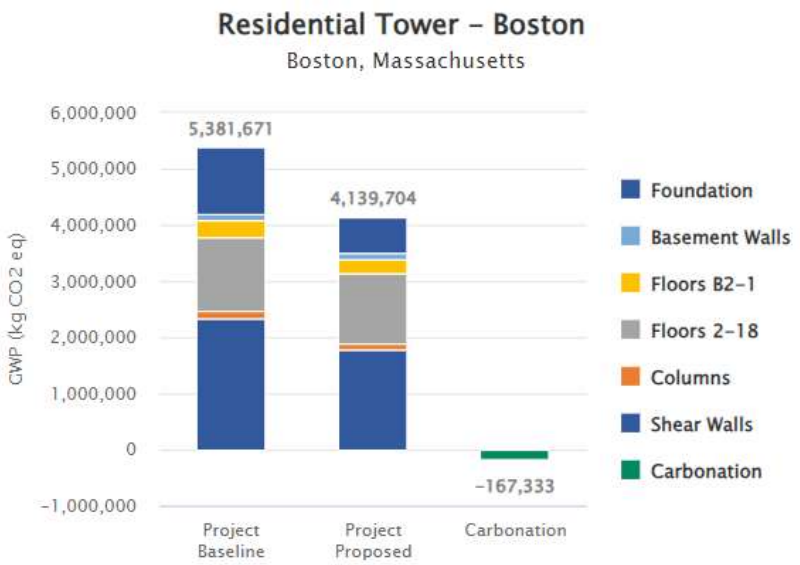
Concrete Budget Report



Mix ID	Application	Concrete Quantity (yd^3)	f'c (PSI)
1	Shear Walls	7,630	6,000
2	Columns	366	8,000
3	Floors 2-18	4,533	5,000
4	Floors B2-1	1,067	5,000
5	Basement Walls	444	5,000
6	Foundation	3,844	6,000

This report was generated using the NRMCA's this analysis indicate that an estimated **-23.08** scope on **Residential Tower - Boston***. The ba **Eastern**.

*This study includes the following life cycle st



Mix ID	Application	Concrete Quantity (yd^3)	f'c (PSI)	Baseline GWP ($kgCO2e/yd^3$)	Proposed Mix GWP ($kgCO2e/yd^3$)	Total Project Baseline GWP ($kgCO2e/yd^3$)	Total Project Proposed GWP (kgCO2e/project)	Difference from Baseline	Carbonation (kgCO2e/project)
1	Shear Walls	7,630	6,000	305.3	232	2,329,439	1,770,160	-24 %	-74,774
2	Columns	366	8,000	360.5	303	131,943	110,898	-16 %	-6,515
3	Floors 2-18	4,533	5,000	289	277	1,310,037	1,255,641	-4.2 %	-56,209
4	Floors B2-1	1,067	5,000	289	249	308,363	265,683	-13.8 %	-18,886
5	Basement Walls	444	5,000	289	220	128,316	97,680	-23.9 %	-8,258
6	Foundation	3,844	6,000	305.3	166.4	1,173,573	639,642	-45.5 %	-2,691
						5,381,671	**4,139,704**	**-23.1%**	**-167,333**

ions (continued):

ualifications: A company manufacturing ready mixed concrete who ments for production facilities and equipment

concrete plants with current certification under the NRMCA ncrete Production Facilities, certification or approval by a state or Criteria of equivalent certification shall be included in the submittal.

responsibility for concrete mixtures shall document qualifications experience with concrete technology and development of performance- ied as an NRMCA Concrete Technologist Level 2, or equivalent. Details ion program shall be documented in the submittal.

urer shall furnish a Quality Plan

te supplier participated in supplying data to the NRMCA Cradle-to-Gate -Mixed Concrete.

total GWP of all proposed concrete on the project is less than or equal **ents or a weighted average of 241 kgCO2e/yd3.**





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Final Results

Project	Project GWP (kg)	Weighted GWP (kg/yd^3)	GWP Reduction
Benchmark Mixes	**5,382,000**	**301**	**0**
Proposed with Fly Ash and Slag Mixes	**4,140,000**	**232**	**- 23%**
Establish Carbon Budget	**4,300,000**	**240**	**- 20%***

* Consider added buffer/tolerance

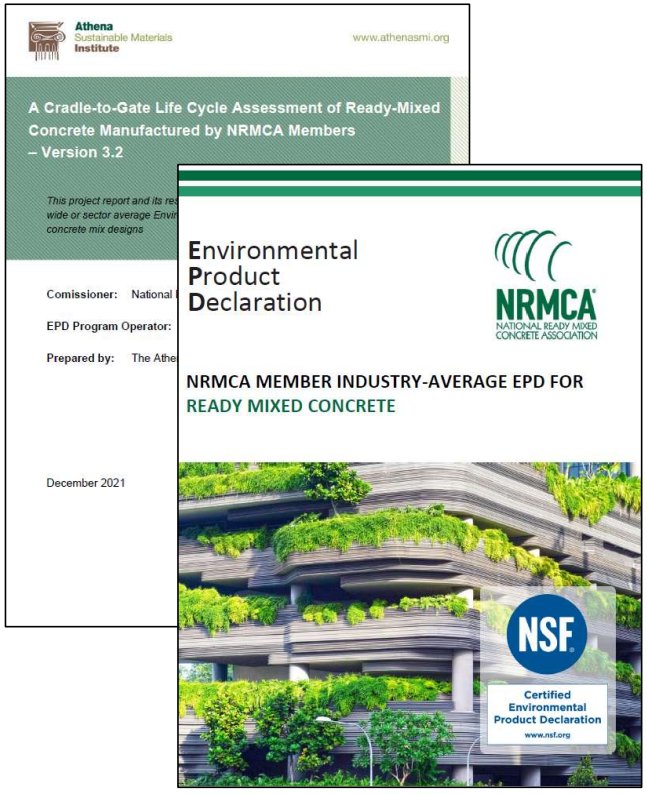


Set Targets for Carbon Footprint

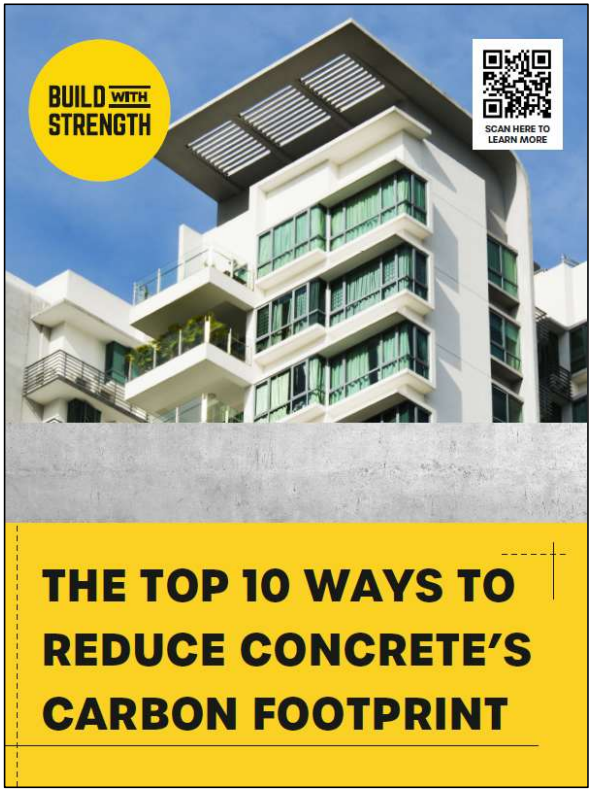
- **Concrete Materials:**

A. Supply concrete mixtures such that the total Global Warming Potential (GWP) of all concrete on the project is less than or equal to **4,300,000 kg** of CO2 equivalents or a weighted average of **240 kgCO2e/yd3**

Concrete Resources







www.nrmca.org/sustainability **www.BuildWithStrength.com**