

NRMCA Concrete Innovations | Session 19 April 17, 2024

# Sustainable concrete

in the Building Industry: Opportunities & Challenges

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ZGF

## ZGF Architects

### Offices

**745+**  
EMPLOYEES FIRMWIDE

### Sustainability

<b>16</b> Buildings	<b>9</b> Buildings	<b>45</b> Buildings
<b>7</b> Buildings	<b>3</b> Buildings	<b>25</b> Buildings

## Just.

Organization Name: ZGF Architects  
 Organization Type: Architecture  
 Headquarters: Portland, Oregon  
 Number of Employees: 745

**Social Justice Indicators:**

<b>Diversity &amp; Inclusion</b>	<b>Employee Benefits</b>
<ul style="list-style-type: none"> <li>Gender Diversity</li> <li>Race Diversity</li> <li>Hispanic</li> <li>Engagement</li> </ul>	<ul style="list-style-type: none"> <li>Health Care</li> <li>Retirement Programs</li> <li>Family Medical Leave</li> <li>Flexible Working Schedules</li> </ul>
<b>Equity</b>	<b>Stewardship</b>
<ul style="list-style-type: none"> <li>Full-time Employment</li> <li>Part-time/Seasonal</li> <li>Partnership/Association</li> <li>Living Wage</li> <li>Gender Pay Equity</li> </ul>	<ul style="list-style-type: none"> <li>Long-term Commitment</li> <li>Community</li> <li>Artwork/Artists</li> <li>Capitalism/Investment</li> <li>Humanity/Progress</li> </ul>
<b>Employee Health</b>	<b>Purchasing &amp; Supply Chain</b>
<ul style="list-style-type: none"> <li>Physical Health</li> <li>Mental Health</li> </ul>	<ul style="list-style-type: none"> <li>Responsible Procurement</li> <li>Supplier Diversity</li> </ul>

THE SOCIAL JUSTICE LABEL 2.0  
 ZGF-002  
 APR 2023/2024  
 INTERNATIONAL LEADERS FUTURE PIONEER

### Awards & Recognition

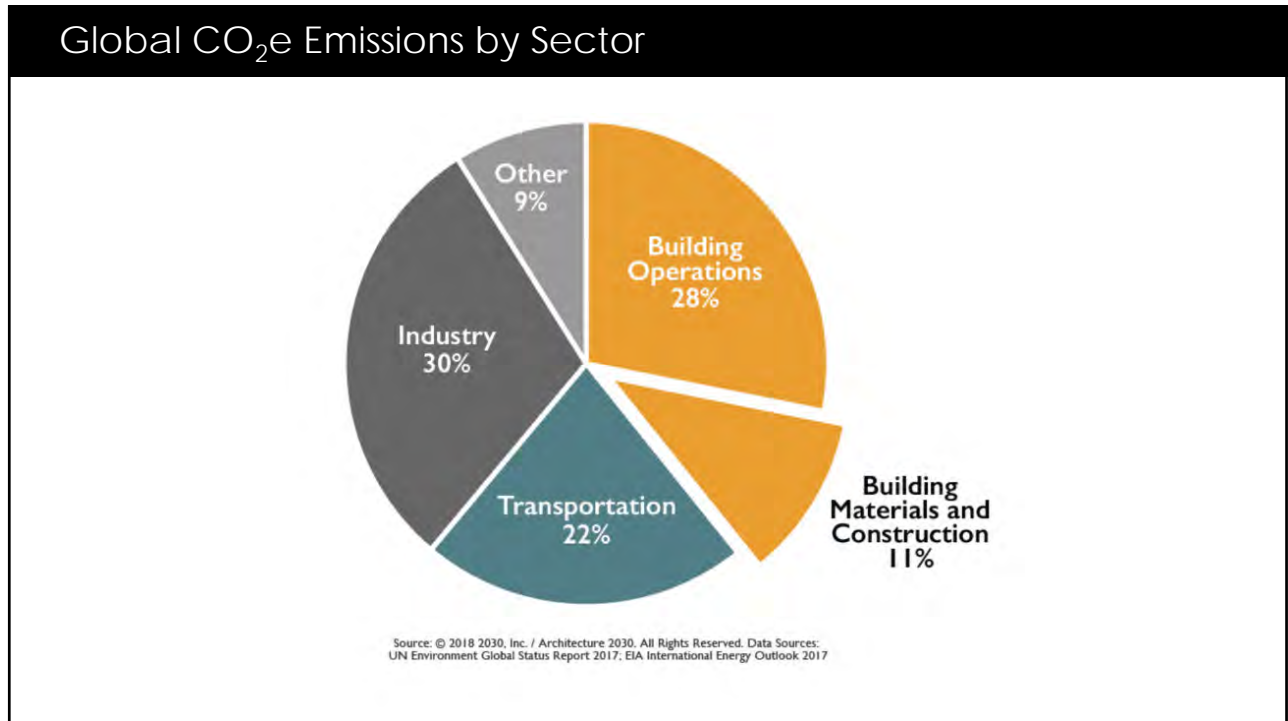
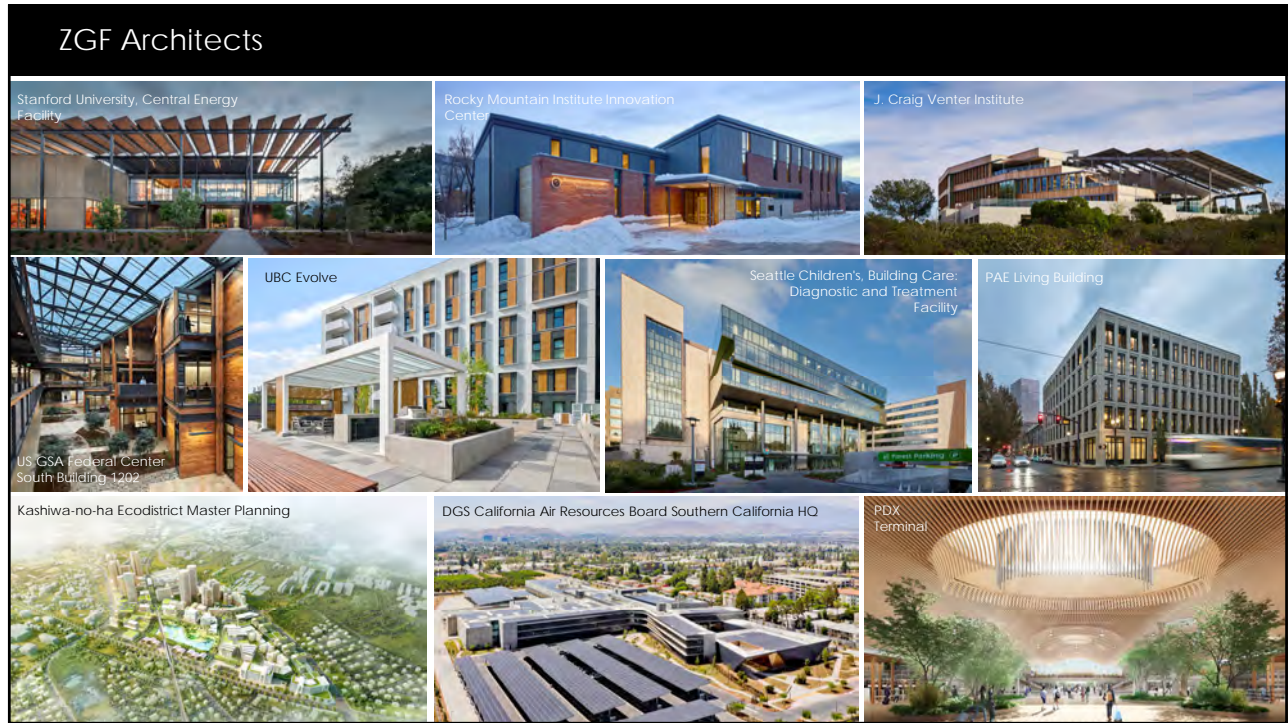
**1,200+**  
Design Awards

**FAST COMPANY**  
10 Most Innovative Companies: Architecture 2023 & 2024

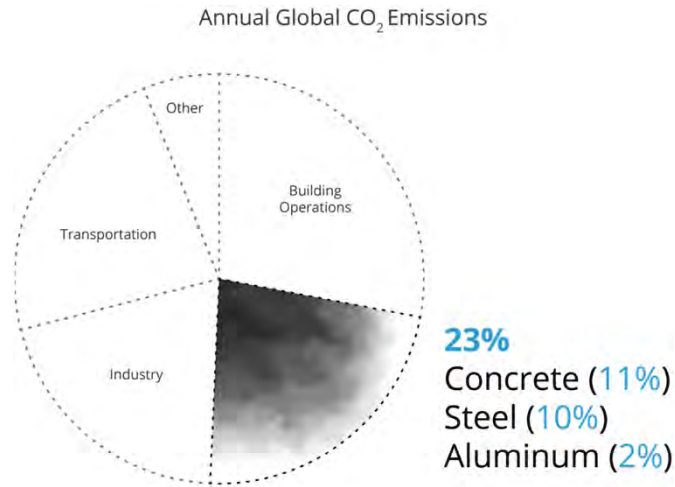
**A 50**  
ARCHITECT 50  
TOP 50 FIRMS  
Overall 2018  
in Sustainability 2017 & 2018  
Architect Magazine

### Services

Urban Design	Open Space Planning	Landscape Architecture	Community Engagement	Programming
Architecture	Interior Design	Experiential Graphic Design	Fabrication	Sustainable Design

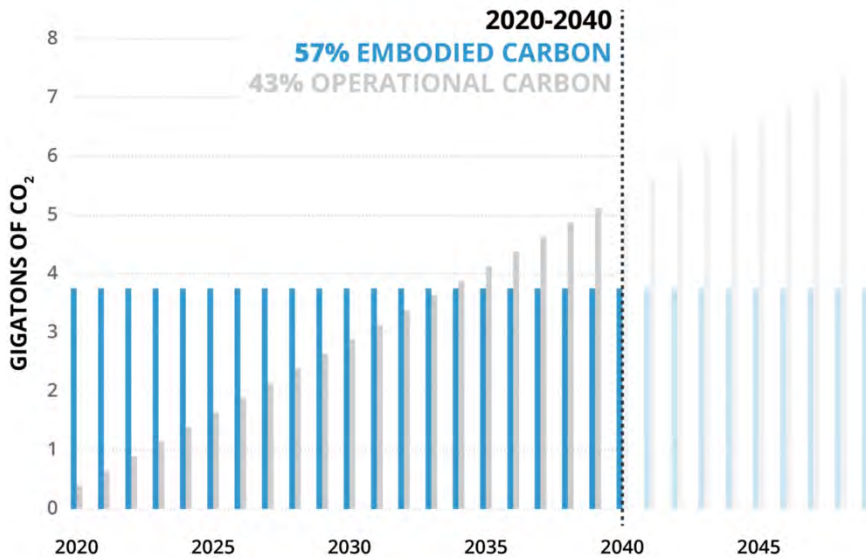


## Global CO<sub>2</sub>e Emissions by Sector



© Architecture 2030. All Rights Reserved.  
Data Sources: Global ABC Global Status Report 2018, EIA

## Total Carbon Emissions of Global New Construction (Business as Usual Projection)



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Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017



**Amazon HQ2**

LEED Platinum, All-electric zero emissions (ILFI Zero Carbon "Ready")

Post-tensioned slabs, mild reinforced slabs, columns, mat slab, and 4-story subterranean garage

**21%** red.  
vs. NRMCA 2019 EPD

- Advance market engagement
- ZGF concrete tool
- EPD requirement
- High SCMs (slag)
- Carbon Cure
- Batch plant



Amazon HQ2

**Miller & Long**  
Inc Design Partner  
Met Park T & R

Shapiro & Associates  
18441 Cornerstone Place  
Columbia, MD, VA 21046  
Office: 410.311.1241

**DATE OF REPORT**  
07/18/2024

**ME DESIGN**

Material	Qty (CY)	Unit
Concrete (Type III)	470	cy
Steel rebar #10	420	lb
Classified Aggregates	1850	cy
Flow Aggregate (Pulver)	154	cy
Solid Waste	245	cy
Asphalt	7	cy
Form & Release	12	sq ft
Form Release (Water)	12	gal
Form Release (Oil)	12	gal
Hydraulic Stabilizer	18	sq ft

**COMPARISON TO REGIONAL AVERAGE**

Material	SWP	SWP
SCC PE (Normal Weight)	554	kg CO <sub>2</sub> /m <sup>3</sup>

**ENVIRONMENTAL IMPACTS**

**Declared Product:**  
10000 cu yds Concrete  
Compressive strength: 4000 psi  
Compressive strength: 4000 psi

**Declared Load:** 1 m<sup>3</sup> of concrete

Material	Weight (kg)	CO <sub>2</sub> (kg)
Concrete (Type III)	10000	10000
Steel rebar #10	420	420
Classified Aggregates	1850	1850
Flow Aggregate (Pulver)	154	154
Solid Waste	245	245
Asphalt	7	7
Form & Release	12	12
Form Release (Water)	12	12
Form Release (Oil)	12	12
Hydraulic Stabilizer	18	18

**Product Categories:** concrete (10000 cu yds), steel rebar #10 (420 lb), asphalt (7 cu yd), form release (water) (12 gal), form release (oil) (12 gal), hydraulic stabilizer (18 gal)

**SWP Values:**  
2023/2024 Total CO<sub>2</sub> 10000  
2023/2024 Total CO<sub>2</sub> 10000  
2023/2024 Total CO<sub>2</sub> 10000

**climate earth**

Amazon HQ2



**The Douglass**

Targeting LEED Platinum, ILFI Zero Carbon

Post-tensioned slabs, columns, mat slab and 2-story subterranean garage

**34%** red.

vs. NRMCA 2022 EPD

- High SCM mixes
- Carbon Cure
- Batch plant



## The Douglass: Concrete bid tool

### SECTION 033000 – CAST-IN-PLACE CONCRETE

#### GENERAL

#### 1.1 SECTION INCLUDES

- A. Cast-In-Place Concrete.
- B. Steel Rebar.

#### 1.2 DEFINITIONS

- A. Embodied Carbon of a Building Material or Product: The greenhouse gas emissions associated with the cradle-to-gate life cycle stages, raw material extraction, transportation, and manufacturing and processing, of a building material. On an Environmental Product Declaration (EPD), the Global Warming Potential (GWP) for scopes A1-A3.

#### 2.1 PERFORMANCE REQUIREMENTS - SUSTAINABILITY

- A. Embodied Carbon:
  - 1. Cast-In-Place Concrete: Provide concrete mix designs that show at least a 20% reduction in Total Project Concrete Embodied Carbon.
    - a. Total Project Concrete Embodied Carbon (GWP) from Concrete Mixes = The sum of Embodied Carbon for Each Concrete Type included in the project.
      - 1) Embodied Carbon for Each Concrete Type = Concrete mix's embodied carbon per declared unit x quantity of concrete.
    - b. Individual Embodied Carbon (GWP) Baseline for Concrete Mixes: 2022 NRMCA Eastern Regional benchmarks in kg CO2eq per yd3 for each strength mix at 28 days.

Strength (psi)	Baseline 2022 NRMCA Eastern Region (kgCO2e/CY)
3000	201.48
4000	240.22
4500 LW	459
4500	264.63
5000	289.03
6000	305.26
8000	360.51
10000	415.76

- c. Embodied Carbon Reduction: Some applications of cast-in-place concrete, like foundations and retaining walls, may allow for higher reductions than others.
- d. See Alternate No. 1 – Concrete Carbon Reduction in Section 012300 – ALTERNATES.
- e. Provide a Product Specific Type III Environmental Product Declaration (EPD), that meets the following parameters, and documents that each concrete mix product's Global Warming Potential (GWP) is at or below the Embodied Carbon Limit.
  - 1) System Boundary: Product Stage, A1-A3.
  - 2) Declared Units: Cubic yard (yd3).
  - 3) Product Category Rule: Any of the following:
    - a) NSF International PCR for Concrete, v.1, 2019-02-22.
    - b) ISO PCR for ISO 21930 – Sustainability in buildings and civil engineering works, v.1, 2017.
    - c) Carbon Leadership Forum PCR for Concrete, v1.1, 2013-12-04.
    - d) Comparable listed in EC3.
- f. During the design and construction process, it is acceptable to use the ZGF Concrete LCA Calculator to estimate concrete embodied carbon reductions while EPDs are being developed.

#### 2. Steel Rebar

- a. Embodied Carbon (GWP) Baseline(s): 1.7 kg CO2eq per kg; "Baseline (High)" as set in the document "2021 CLF Material Baselines" by the Carbon Leadership Forum.
- b. Provide a Product-Specific Type III Environmental Product Declaration (EPD), that meets the following parameters, and documents that each steel rebar product's Global Warming Potential (GWP) is at least 30% better than the baseline.
  - 1) System Boundary: Product State A1-A3.
  - 2) Declared Units: kg.
  - 3) Product Category Rule:
    - a) SCS Global Services PCR for Designated Steel Construction Products, v1.0, 2015-05-05.
    - b) CEN PCR for CEN standard EN 15804, v.1, 2012-01-01.
    - c) Comparable listed in EC3.

## The Douglass: Concrete bid tool

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	<b>Instructions:</b> Please fill in the cells highlighted in BLUE only. Per Specification 033000, targeted reductions in concrete GWP are based on total project GWP rather than mix by mix. This is meant to provide flexibility in pathways to achieve each target.													
2														
3														
							Base Bid Item		Alternate Bid Item #1		Alternate Bid Item #2			
				NRMCA Baseline Mix GWP (kgCO2e/CY)	Total Baseline GWP per mix (kgCO2e)		Mix GWP for 40% Reduction (kgCO2e/CY)	Total GWP per mix (kgCO2e)		Mix GWP for 20% Reduction (kgCO2e/CY)	Total GWP per mix (kgCO2e)		Mix GWP for Maximum Reduction With No Cost Premium (kgCO2e/CY)	Total GWP per mix (kgCO2e)
4	Application	Mix (PSI)	CY											
5	Mat Foundation	5000	100	321.35	32135		150	15000		250	25000		200	20000
6	Foundation Walls B1	5000		321.35	0									
7	Foundation Walls B2	6000		339.48	0									
8	Retaining Wall - Foundation	3000		223.22	0									
9	Retaining Walls	4500		294	0									
10	Slabs and Beams	6000		339.48	0									
11	Slabs and Beams	5000		321.35	0									
12	Slabs and Beams	(LW) 4500		487.72	0									
13	Shear Walls	10000		462.4	0									
14	Shear Walls	8000		401.4	0									
15	Shear Walls	6000		339.48	0									
16	Shear Walls	5000		321.35	0									
17	Columns	10000		462.4	0									
18	Columns	8000		401.4	0									
19	Columns	6000		339.48	0									
20	Columns	5000		321.35	0									
21	Curbs	(AE) 4500		294	0									
22	Interior Topping Slabs	(LW) 3000		416.94	0									
23				Baseline Project GWP (kgCO2e)	32135		Project GWP	15000		Project GWP	25000		Project GWP	20000
24				% Reduction	0		% Reduction (40% min)	53.32192314		% Reduction (20% min)	22.20320523		% Reduction	37.76256418

**Seattle Storm**

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Targeting LEED Gold, all-electric (ILFI Zero Carbon "Ready")

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Tilt-up walls, piles, grade beams, slab on grade

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**40%+\*** red.  
 vs. NRMCA 2022 EPD

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- Type 1L PLC
- 28 & 56 day strength
- High SCM (up to 80%)



Tilt-up concrete

**RATING**  
 4HRS PER SBC  
 SECTION 722.2.1.21 -  
 EQUATION 7-4  
 $(25.1 \wedge 0.59 + 10 \wedge 0.59 + 6.5 \wedge 0.59) \wedge 1.7 = 84.5 >> 25.5$

**CODE REQUIREMENT**  
 S2018 SEC  
 A103.37.1(12), SOLID  
 CONCRETE WALL, NO  
 FRAMING, R-20,  
 CODE MINU-0.057

**ASSEMBLY**  
 U-VALUE = .047

CONDITIONED SPACE

7 1/4" 4" 2 1/4" 3/4"

CLEAR WATER REPELLENT AND ANTI-GRAFFITI COATING

FACING CONCRETE

4" XPS INSULATION, R5/INCH (R=20)

FIBERGLASS CONCRETE TIE

STRUCTURAL CONCRETE

EXTERIOR SPACE

**WA-01** WA-01 - CONCRETE SANDWICH WALL PANEL  
 3" = 1'-0"



EC3 research

4000 psi Concrete

Tally/NRMCA avg C2G baseline:  
**269.14 kgCO<sub>2</sub>e/CY**  
(from ZGF Concrete tool)



Specifications

REGION <sup>1</sup>	SAN FRANCISCO / LOS ANGELES, CA		PORTLAND, OR / SEATTLE, WA	
	PORTLAND CEMENT LIMITS (LBS/CY) <sup>2,3</sup>	EMBODIED CARBON LIMITS (KG CO <sub>2</sub> e/M <sup>3</sup> ) <sup>2,3</sup>	PORTLAND CEMENT LIMITS (LBS/CY) <sup>2,3</sup>	EMBODIED CARBON LIMITS (KG CO <sub>2</sub> e/M <sup>3</sup> ) <sup>2,3</sup>
0 - 2500 psi	362	260	244	266 203
2501 - 3000 psi	410	298	276	291 222 → 215
3001 - 4000 psi	456	313	311	343 262 → 251
4001 - 5000 psi	503	338	437	406 310
5001 - 6000 psi	531	356	462	429 328 → 312
6001 - 8000 psi	594	394	594	493 381
> 8001 psi	657	433	657	535 409

Concrete submittals

The image displays six concrete submittal forms for Stoneway Concrete. Each form includes a header with the company logo and name, followed by project and location information. The forms are organized into columns, each representing a different concrete mixture. Each form contains a 'Material' table with columns for 'Material', 'Source', 'Description', 'Specific Gravity', 'Volume', and 'Weight'. Below the tables are sections for 'NOTES', 'COMMENTS', and 'SUBMITTAL SPECIFIC NOTES'. A 'REVIEWED' stamp is visible on the right side of the forms.

**First Movers Coalition** Cement & Concrete

Member countries: Canada, Norway, Denmark, Singapore, Germany, Sweden, India, United Arab Emirates, Italy, United Kingdom, Japan, United States, Australia.

- <https://initiatives.weforum.org/first-movers-coalition/home>
- Launched by President Biden at COP26 to spur development in clean energy technologies. Other sectors include Aluminum, Aviation, Shipping, Steel, Trucking, Carbon Dioxide Removal
- Cement & Concrete members commit to **purchasing or specifying at least 10% of their annual cement / concrete procurement volume as of near-zero emission cement / concrete by 2030.**
- Concrete group Includes Consolidated Contractors Group, Etex, General Motors, RMZ, Vattenfall, Ørsted, ZGF Architects and 13 government partners

Specified compressive strength (f'c in psi)	Embodied carbon (kg CO2 e/m3)	NRMCA 2022 PNW regional EPD	Red.
0 - 2500 psi	70	138	49%
2501 - 3000 psi	78	153	49%
3001 - 4000 psi	96	185	48%
4001 - 5000 psi	117	226	48%
5001 - 6000 psi	124	238	48%
6001 - 8000 psi	144	285	49%



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Opportunities & Challenges

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