Policies on Embodied Carbon

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Bruce King, Ecological Building Network
Kathryn Phillips, Sierra Club
Eden Brukman, City of San Francisco

Embodied Carbon Policy Options

Prescriptive Performance
Simple Flexible
Attribute-based Complex
### Embodied Carbon Policy Options

<table>
<thead>
<tr>
<th>Prescriptive</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Palette</td>
<td>Buy Clean Acts</td>
</tr>
<tr>
<td>Design Guidelines</td>
<td>WB LCA</td>
</tr>
</tbody>
</table>

#### a concrete suggestion

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Bruce King
Getting to Zero
Oakland, California
October, 2019
this human moment on Earth

Atmospheric CO₂ Concentration

Thousands Of Years Ago

Drawdown

Atmospheric CO₂ Concentration

Thousands Of Years Ago
Where can we put the carbon?

soil

buildings

another New York City every 35 days
buildings and greenhouse gases

40%

buildings and greenhouse gases

operating emissions

embodied emissions

time

carbon emissions
buildings and greenhouse gases

- carbon emissions vs. time
  - operating emissions
  - embodied emissions

the next twenty years
buildings and greenhouse gases

the next twenty years

embodied emissions: the materials we use

10%
building materials

*effectively much more than 10% –*

the time value of carbon

Climate Impact

the time value of carbon –

the time it’s in the air!

the next twenty years
of a building project’s climate impact over the next twenty years is from embodied carbon

Where is the embodied carbon?

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity of Material</th>
<th>Unit of Material (tons)</th>
<th>Tons of CO₂ per Unit of Material</th>
<th>Tons of CO₂ Emissions</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>620</td>
<td>CY</td>
<td>0.3</td>
<td>186</td>
<td>62%</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>81</td>
<td>tons</td>
<td>1.05</td>
<td>85</td>
<td>28%</td>
</tr>
<tr>
<td>Reinforcing Steel</td>
<td>11</td>
<td>tons</td>
<td>1.05</td>
<td>12</td>
<td>4%</td>
</tr>
<tr>
<td>Carpet</td>
<td>3</td>
<td>tons</td>
<td>3.10</td>
<td>9</td>
<td>3%</td>
</tr>
<tr>
<td>Steel Studs</td>
<td>4</td>
<td>tons</td>
<td>1.05</td>
<td>4</td>
<td>1%</td>
</tr>
<tr>
<td>Glass</td>
<td>2</td>
<td>tons</td>
<td>1.30</td>
<td>2</td>
<td>1%</td>
</tr>
<tr>
<td>Gypsum Board</td>
<td>6</td>
<td>tons</td>
<td>0.20</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>0.4</td>
<td>tons</td>
<td>2.10</td>
<td>1</td>
<td>0.3%</td>
</tr>
<tr>
<td>Ceramic Tile</td>
<td>0.3</td>
<td>tons</td>
<td>1.40</td>
<td>0</td>
<td>0.1%</td>
</tr>
<tr>
<td>Battuinsulation</td>
<td>0.4</td>
<td>tons</td>
<td>1.50</td>
<td>1</td>
<td>0.2%</td>
</tr>
<tr>
<td>Acoustic Ceiling Tile</td>
<td>1</td>
<td>tons</td>
<td>0.20</td>
<td>0</td>
<td>0.1%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>302</strong></td>
<td><strong>302</strong></td>
<td><strong>302</strong></td>
<td><strong>302</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Scott Shell, AIA, EHDD Architects, San Francisco, California

94% of CO₂ footprint from structural materials
Concrete

8% of global emissions

a great place to start

the low-carbon concrete project

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the low-carbon concrete project

paths to low-carbon concrete

Ordinary concrete

- use less Portland cement
- use supplementary cementitious materials (SCMs) like slag or fly ash
- extend time to T^* (compressive strength)
- better (stronger) aggregate
- alternate cements
  (e.g., Magnesium Oxide, or clay, aka "notches construction")
- use blended cements (clincher intermixed with limestone powder or other SCMs)

- use more carbon 
  - carbonate aggregate 
    (e.g., Blue Planet, Calera) 
  - augmented strengths 
    (e.g., Calcrete, geopectra)

reduce waste
- use reclaimed concrete as aggregate
- use returned concrete
- don’t specify what you don’t need
- use strength of concrete

Low-carbon concrete

---

the low-carbon concrete project

<table>
<thead>
<tr>
<th>Minimum specified compressive strength $f_c$, psi (5, 7)</th>
<th>Cement limits for use with any compliance method 19.07.050.1 thru 19.07.050.4</th>
<th>GWP limits for use with any compliance method 19.07.050.1 thru 19.07.050.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 2500 (3.4)</td>
<td>Maximum ordinary Portland cement content, lbs/yr^3 (1, 2, 4)</td>
<td>Maximum Global Warming Potential, GWP, kg CO2e/m^3</td>
</tr>
<tr>
<td>3000</td>
<td>410</td>
<td>289</td>
</tr>
<tr>
<td>4000</td>
<td>456</td>
<td>313</td>
</tr>
<tr>
<td>5000</td>
<td>503</td>
<td>338</td>
</tr>
<tr>
<td>6000</td>
<td>531</td>
<td>356</td>
</tr>
<tr>
<td>7000</td>
<td>594</td>
<td>394</td>
</tr>
<tr>
<td>7001 and higher</td>
<td>657</td>
<td>433</td>
</tr>
<tr>
<td>up to 3000 light weight</td>
<td>512</td>
<td>578</td>
</tr>
<tr>
<td>4000 light weight</td>
<td>571</td>
<td>626</td>
</tr>
<tr>
<td>5000 light weight</td>
<td>629</td>
<td>675</td>
</tr>
</tbody>
</table>

Table 19.07.050.1 – Cement and GWP limitations
the low-carbon concrete project

Notes
(1) Portland cement of any type per ASTM C150. The maximum cement content may be increased proportionately above the tabulated value when using an approved cement, or blended cement, demonstrated by approved EPD to have a plant-specific global warming potential (GWP100) lower than 1040 kg CO2e/metric ton. The increase in allowable cement content would be \((1040 / \text{GWP})\)%.

(2) Cement or GWP limits shown can be increased by 30% for concretes demonstrated to the Building Official as requiring high early strength. Such concretes could include:
   a. Precast, prestressed concrete
   b. Beams and slabs above grade
   c. Shotcrete

(3) Concrete with designated strength less than 2500 psi is not subject to minimum strength and reinforcing limitations of AGCI 318.

(4) Concrete using clay, or both clay and cement, as binder shall be designed and constructed consistent with successful historical precedent or existing standards, or substantiated by test data, and is subject to approval by the Building Official. Clay-based concrete systems, historically known as earthen construction, include adobe (unfired earth) blocks, compressed earth blocks, cob (or puddled earth), and rammed earth. Concrete using both clay and cement, historically known as soil-cement, include roller-compact concrete or road base, stabilized rammed earth, and stabilized earth block.

(5) The permit applicant must designate the time allotted for a concrete mix to reach its minimum specified compressive strength, be it 28, 56, 84 days or more.

(6) For concrete strengths between the stated values, use linear interpolation to determine cement and/or GWP limits.

the low-carbon concrete project

When deviations from compliance with this section occur the chief building official is authorized to require evidence of equivalent carbon reductions from the portions of remaining construction of the project to demonstrate alternative compliance with the intent of this chapter.
a price on carbon

the
low-carbon
cement
building code
the low-carbon concrete project

- because concrete is everywhere

- Has to start somewhere and Bay Area is perfect
the low-carbon concrete project

• because concrete is everywhere

• Has to start somewhere
  and Bay Area is perfect

• Let’s get viral
  a sneaky guerilla building code

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Building codes vs. Public Procurement

Outreach: concrete producers
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Building codes vs. Public Procurement

Outreach: concrete producers engineers

other jurisdictions
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Building codes vs. Public Procurement

Outreach: concrete producers
engineers
other jurisdictions
other countries

Buy Clean CA and Beyond

Kathryn Phillips
Director
Sierra Club California
Kathryn.Phillips@sierraclub.org
Buy Clean CA Act Basics

• Who did it
• Why we did it
• What it is
• When it happens

The Who
An unexpected campaign coalition

Rule #1: Who you hang out with matters.
Rule #2: How you spend your money matters.
The When

- Department of General Services (DGS) responsible for implementation
  - AB 262 Implementation Website
- Phase-in timeline
  - Jan. 1, 2019: request contractors to submit EPDs for project materials
  - Jan. 1, 2020: require contractors to submit EPDs for project materials
  - Jan. 1, 2021: DGS to establish global warming pollution (GWP) limit
  - July 1, 2021: require EPDs that meet GWP limit

*Rule #3: All good things are worth waiting for, but not too long.*

Other Buy Cleans

*Popularizing the concept*
Thank You

Material Impacts
Bringing Cities Together to Advance Climate Action

Embodied Carbon Workgroup

Clean Construction Workgroup
Forum: 20-23 May 2019, Norway

Zürich: Harmonized, Public, Free LCA Data bit.ly/2k20KZE
Oslo: Clean Construction bit.ly/2luSoPW

Vancouver: Low Carbon Materials & Designs bit.ly/2k0pOQL
Embodied Carbon: Places to Intervene in a System

Embodied Carbon: Opportunities for Intervention
Balancing Single Actions and Systems Change

End of Presentation
Current (Design,)C&D Practices Still Lead to Landfill

25% (*excludes “Alternative Daily Cover”)

Finding Solutions for Urban Wood Waste
Upstream: Adaptive Reuse

Upstream: Optimize Density

Image from "Accessory Dwelling Units in San Francisco" 2018
https://sfdplanning.org/about-accessory-dwelling-units
Upstream: Design for Disassembly

Upstream/Downstream: Material Reuse
Downstream: Construction Surplus and Interiors Refresh

Downstream: Deconstruction and Source Separation