EE 23: REDUCE CO2 EMISSIONS DUE TO CONCRETE

New York City Building Code and Administrative Code
Proposal developed by the Materials & VOCs Committee

Summary

Issue:
Manufacturing cement, a significant component of concrete, requires large amounts of energy that produce significant quantities of CO2. Cement can easily be replaced in concrete with less energy-intensive materials.

Recommendation:
Limit the amount of cement permitted in concrete, substituting other cementitious materials, such as readily available industrial by-products.

Proposed Legislation, Rule or Study

Amendments to the New York City Building Code:
1. Amend Section 1905.2 as follows:

1905.2 Selection of concrete proportions. Concrete proportions shall be determined in accordance with the provisions of Sections 1905.2.1 through [1905.2.3.] 1905.2.4.

2. Add a new Section 1905.2.4 as follows:

1905.2.4 Maximum cement content. All concrete mixes requiring a compressive strength of 14,000 psi or less shall contain a maximum of 400 lbs. of Portland cement per cubic yard of concrete.

Amendments to the Administrative Code of the City of New York:
1. Add a new Section 6-308.1 as follows:

§ 6-308.1 Maximum cement content.

a. No concrete mixes requiring a compressive strength of 14,000 psi or less purchased by any agency shall contain more than four hundred pounds of Portland cement per cubic yard of concrete.

b. The director shall conduct an inter-agency study on the availability and cost of pre-cast concrete units purchased by agencies that could meet the requirements of Portland cement content as set forth in subdivision (a). No later than July 1, 2011, the director shall promulgate rules seeking to minimize the content of Portland cement in pre-cast concrete units purchased by agencies, while considering commercial availability, suitability of use and comparative cost.

c. The department of transportation shall promulgate rules no later than July 1, 2011 that incorporate the standards for Portland cement content as set forth in subdivision (a) in all specifications for sidewalk construction.

Supporting Information

Issue – Expanded
Cement manufacturing is responsible for 3.4-5% of global carbon emissions and is the largest source of U.S. emissions after fossil fuel consumption. The primary source of carbon emissions from cement production is the use of coal and petroleum to fuel kilns. The production one ton of Portland cement results in the emission of approximately one ton of CO2.
All concrete can be made with reduced amounts of Portland cement by using supplementary cementitious materials. The materials are typically fly ash, ground granulated blast-furnace slag (GGBFS) and silica fume, all of which are by-products of industrial processes that are typically placed in landfills. Since they are waste products, the use of supplementary cementitious materials directly offsets the CO₂ that would otherwise be released in cement production.

Fly ash can replace up to 50% of Portland cement in concrete mixtures, and the use of 25% fly ash is already common. GGBFS commonly replaces up to 40% of cement, and has replaced up to 80%. Silica fume can replace 5% to 7% of cement. In addition to reducing CO₂ emissions, fly ash and blast furnace slag increase the workability of concrete, which aids finishing operations, and reduce water demand. Supplementary cementitious materials also reduce the permeability of concrete, making them a necessary ingredient in concrete that has reinforcing steel or is subjected to chlorides, such as parking structures, bridge decks, road pavements and marine structures.

Environmental & Health Benefits
As previously discussed, replacing Portland cement with fly ash reduces greenhouse gas emissions. Each cubic yard of concrete produced in New York City is estimated to include 650 lbs of cement, as required under the old building code. By capping cement content at 400 lbs by 2010, this proposal will reduce concrete usage by a minimum of 250 lbs per cubic yard of cement used. With NYC using over 2 million cubic yards of concrete annually, this proposal will result in an annual reduction of 250,000 tons of CO₂.

According to New York City’s 2009 Inventory of Greenhouse Gas Emissions, the city’s CO₂ emissions were 53.3 million metric tons in 2008. Therefore, this proposal will reduce NYC’s CO₂ emissions by 0.5% in 2010. By way of comparison, converting the city’s taxi and black car fleet to hybrids is estimated to reduce the city’s CO₂ emissions by 0.43%.

This proposal was found to have a high, positive environmental impact per building and to impact a large number of buildings. It was thus given an environmental score of 3.

This proposal was found to have no significant positive health impact.

Cost & Savings
This proposal is not expected to have any significant impact on capital costs.

Precedents
Although no known precedents exist for limiting the amount of Portland cement used in concrete mixtures, several municipalities allow for the substitution of supplementary cementitious materials for Portland cement. For example, California has adopted the use of cementitious alternatives into the state’s green building standards, including the use of fly ash, slag cement up to 70% replacement levels, and silica fume up to 7% replacement levels.

The Port Authority of NY & NJ has substituted large quantities of supplementary cementitious materials for Portland cement in concrete mix proportions used at its facilities for various applications. These mix proportions produced concrete with high compressive strength and excellent durability. Some examples of these concrete mix proportions are given below:

<table>
<thead>
<tr>
<th>Supplementary Portland Cement (Lbs.)</th>
<th>Cementitious Materials (Lbs.)</th>
<th>Compressive Strength (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>320</td>
<td>5000</td>
</tr>
<tr>
<td>340</td>
<td>230</td>
<td>6500</td>
</tr>
<tr>
<td>350</td>
<td>300</td>
<td>8000</td>
</tr>
<tr>
<td>300</td>
<td>496</td>
<td>12000</td>
</tr>
<tr>
<td>300</td>
<td>580</td>
<td>14000</td>
</tr>
</tbody>
</table>

In winter weather, cold temperatures, to increase strength gain an admixture, strength accelerator can be added to the concrete mix.

LEED
LEED credits are available for the use of alternative cementitious materials that are derived from industrial by-products.

These credits include: LEED NC- MR cr.4.1 & 4.2 Recycled Content; LEED CI-MR cr. 4.1 & 4.2 Recycled content; LEED EB-MR cr.2 Optimize use of Alternative Materials; LEED for Schools MR cr.4.1 & 4.2 Recycled Content; LEED for Homes MR cr. 2 Environmentally Preferable Products; and credits under the various pilot programs.
Implementation & Market Availability
There are no known implementation issues for this proposal. Alternative cementitious materials are readily available. There are enormous qualities of fly ash available and presently ample quantities of GGBFS.

It may be necessary to bring some concrete suppliers and engineers up to date with the current concrete technology in the use of supplementary cementitious materials. The Concrete Industry Board of NYC is capable and willing to perform this function.

ENDNOTES:


