National Ready Mixed Concrete Association

Position Statement on Heat Island Mitigation

What is a heat island?

A heat island is a metropolitan area which is significantly warmer than its surrounding rural areas. According to research at Lawrence Berkeley National Laboratory (LBNL), the air in a city can be 6-8°F hotter than its surrounding areas. Scientists call these cities "Urban Heat Islands." The reasons for these higher temperatures is that there are fewer trees, shrubs, and other plants to shade buildings, intercept solar radiation, and cool the air by "evapotranspiration." Buildings and pavement made of dark materials absorb the sun's rays instead of reflecting them away, causing the temperature of the surfaces and the air around them to rise [1]. In the evening, the difference can be as high as 22°F (12°C) [2]. Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.

How can you reduce urban heat island?

The research is showing that use of light- and heat-reflective materials, along with careful planting of trees, could lower the average summer afternoon temperature in some cities by as much as 5 degrees, cutting the need for air conditioning by 18 percent. And since all energy, from air-conditioning to lights, uses fuel, these heat island reduction strategies can help reduce global climate change by reducing energy consumption and related greenhouse gas emissions.

Concrete can help reduce urban heat islands.

Light colored concrete pavements absorb less heat and reflect more light than dark-colored materials, therefore, maintaining a low surface temperature. Using concrete for roads and parking areas in urban and suburban areas has been demonstrated to have a positive impact on the localized ambient temperatures and can reduce energy requirements to cool buildings. Concrete's ability to reflect solar radiation is governed by the material's albedo or measure of the solar reflectivity of the material. An object's albedo is the extent to which the material diffusely reflects light from the sun. Although not always an indicator, materials with a light color have a high albedo where materials that appear darker, typically have a lower albedo.

A material's ability to reflect infrared light is directly proportional to a material's ability to reflect heat from the surface. During the hot summer months, the ambient air surrounding dark colored paving or cladding materials can be up to 10 °F warmer [3] than material with a light color, or high albedo. Several studies have been made which illustrate this point. One such study analyzed temperature differentials in California at an ambient temperature of 55 °F for various colored materials [4]. The study found that the maximum temperature differential between a material covered with a black acrylic paint and a material covered with a white acrylic paint was 68 °F. A second study measured the temperature of various pavement types during a hot 90 °F summer day and found that weathered concrete had a temperature of 155 °F at the material surface where dark asphalt had a temperature of 195 °F, 40 degrees higher than the lighter colored concrete pavement [5].

A reduction in heat islands can increase the health of urban residents.

The effect of increase in ambient temperatures in metropolitan areas is apparent when you compare the health of those who reside in the city versus those who reside in more rural areas. Compared to rural areas, cities experience higher rates of heat related illness and death. Heat islands can exacerbate hot weather events or periods, which may cause heat stroke and lead to physical discomfort, heat stroke, organ damage, and even death – especially in vulnerable populations such as the elderly [5]. The Centers for Disease Control and Prevention (CDC) says that excessive heat claims more lives in the United States each year than hurricanes, lightning, tornadoes, floods, and earthquakes combined. Between 1979 and 1998, the CDC estimates that 7,421 deaths resulted from exposure to excessive heat in the U.S. By reducing the temperature of pavements, through the use of light colored pavements such as concrete, one could reduce the ambient temperature of our cities, therefore, reducing the temperature exposure to its residents according to the research at LBNL.

NRMCA encourages adoption of green building practices

The built environment plays a substantial role in environmental health, human welfare and the economic stability of the United States. Building operation accounts for 40% of U.S. energy consumption and waste from construction debris makes up over 35% of all non-industrial waste. Building operations alone contribute over 38% of the U.S.'s carbon dioxide emissions and over 12% of its water consumption. The use of concrete in the built environment can aid in the reduction of energy consumption, carbon dioxide emissions and construction waste of the built environment. The reduction of heat islands is one step towards a greener environment.

Two model heat island ordinances are attached, one for roofs and one for pavements. These models could be used by NRMCA Affiliates, NRMCA members or others interested in supporting sustainable green building practices. For additional information on concrete's role in sustainability visit www.nrmca.org/sustainability or contact John Loyer, Sr. Dir. of State and Local Gov't. Affairs at (703)-675-7603 or jloyer@nrmca.org.

About NRMCA

Founded in 1930, the National Ready Mixed Concrete Association is the leading industry advocate. Our mission is to provide exceptional value for our members by responsibly representing and serving the entire ready mixed concrete through leadership, promotion, education, and partnering to ensure ready mixed concrete is the building material of choice.

References:

[1] Lawrence Berkeley National Laboratory, http://eetd.lbl.gov/HeatIsland/, accessed March 2011.
[2] http://www.epa.gov/heatisld. Accessed January 2011.
[2] LEED 2.2 Reference Guide, United States Green Building Council, 2007.
[3] Berdahl, P. and Bretz, S., "Spectra Solar Reflectance of Various Roof Materials," *Cool Building and Paving Materials Workshop,* Gaithersburg, Maryland, July 1994.
[4] Rosenfeld, A. H.; Akbari, H.; Bretz, S.; Sailor, D.; and Taha, H., "Mitigation of Urban Heat Islands: Materials, Utility Programs, and Updates," Submitted to the *Journal of Energy Efficiency*, Vol. 1, No. 1, 1993.
[5] Cutler J. Cleveland (Topic Editor). 2007. "Heat island." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth August 17, 2006; Last revised February 3, 2007; Retrieved August 13, 2008]

NOTES: The following is a model heat island bill that supports the concept of a state or local jurisdiction adopting heat island reduction strategies for roof systems. This is simply one model. State or local legislatures would need to add particular clauses dealing with enforcement and administration, but this language could form the framework for a state or local jurisdiction bill.

STATE/CITY/JURISDICTION OF

_____

ACT NO. XXX

AN ACT TO ADOPT SUSTAINABLE BUILDING STANDARDS FOR CONSTRUCTION IN THE STATE/CITY/JURISDICTION OF _____

THE STATE/CITY/JURISDICTION OF _____ DO ORDAIN AS FOLLOWS:

Whereas, the state/city/jurisdicion of _____ is committed to reducing elevated temperatures and associated air quality issues stemming from urban heat island effects; and

Whereas, heat absorption and remittance from standard roofing materials raises localized temperatures, increases energy consumed to cool buildings and associated green house gas emissions, deteriorates air quality, and may harm humans, plant life and animal life sensitive to increased temperatures; and

Whereas, roofs designed to reduce heat island effect either through enhanced reflective materials (cool roofs) or incorporating vegetation (green roofs) reduce costs and energy consumption associated with building cooling systems, provide habitat for wildlife, and increase the life cycle of roofs; and

Whereas, green roofing systems will not only reduce the absorption and remittance of atmospheric heat, but also decrease stormwater runoff volumes, thereby reducing strain on public storm drains and subsequent discharge of potentially harmful sediment to local water bodies.

Therefore, be it ordained by the state/city/jurisdiction of _____, as follows:

Section 1. The recitals and findings in the preamble to the ACT are adopted by reference and incorporated as if fully set forth in this section.

Section 2. Heat Island Effect - Roof

Intent: The requirements of this Act are intended to reduce the heat island effect in the state/ city/jurisdiction of _____ and to consequently reduce energy consumption and associated energy use for the buildings of the state/city/jurisdiction.

Definitions:

Cool Roof. Roof that reflects the sun's heat and emits absorbed radiation back into the atmosphere

Heat island effect. Elevated temperature over an urban area when compared to rural areas, typically caused by the increased presence of dark, heat absorbing materials, such as asphalt and dark roofs, in urban areas.

Solar Reflectance. Fraction of solar energy reflected by a material.

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Applicability:

The provisions of this Act are applicable in all zoning designations throughout the state/city/ jurisdiction, except they shall not apply in R1 and R2, to newly constructed buildings and to replacement or repair of greater than 50% by area of existing roofs after the effective date of this Act. The following are exempted from the requirements of this Act:

a. The portion of the roof acting as a substructure for and covered by a rooftop deck, vegetation associated with an extensive or intensive green roof as defined by US Environmental Protection Association, or any area utilized by photovoltaic and solar equipment.

b. A rooftop deck covering a maximum of 1/3 of the rooftop total gross area.

Solar reflectance shall be determined as follows:

a. All roof exterior surface materials shall have a minimum solar reflectance when tested in accordance with ASTM E903 or ASTM E1918, tested with a portable reflectometer at near ambient conditions, labeled by the Cool Roof Rating Council, or labeled as an Energy Star qualified roof product.

Requirements:
Roofing materials shall meet the following requirements:

a. Option 1: Use roofing materials having a Solar Reflectance Index (SRI) equal to or greater than 29 for a steep sloped roof (>2:12 slope) or a SRI of 78 for a low sloped roof (≤2:12 slope) for a minimum of 75% of the roof surface.
b. Option 2: Install a vegetated roof for at least 50% of the roof area.
c. Install a high albedo and vegetated roof surfaces that, in combination, meet the following criteria:

(Area of roof meeting minimum SRI / 0.75) + (Area of vegetated roof / 0.5) $\geq$ Total Roof Area

Section 3. If any section, part of section, paragraph, clause, phrase or word of this Act is declared invalid, the remaining provisions of this Act shall not be affected.

Section 4. This Act shall become effective thirty (30) days after approval its adoption and signature of the Governor/Mayor/Council.

_____
Signed

NOTES: The following is a model heat island law that supports the concept of a state or local jurisdiction adopting heat island reduction strategies for hardscapes. This is simply one model. State or local legislatures would need to add particular clauses dealing with enforcement and administration but this language could form the framework for a state or jurisdiction law.

STATE/CITY/JURISDICTION OF

_____

ACT NO. XXX

AN ACT TO ADOPT SUSTAINABLE BUILDING STANDARDS FOR CONSTRUCTION IN THE STATE/CITY/JURISDICTION OF _____

THE STATE/CITY/JURISDICTION OF _____ DO ORDAIN AS FOLLOWS:

Whereas, the city of _____ is committed to reducing elevated temperatures and associated air quality issues stemming from urban heat island effects; and

Whereas, heat absorption and remittance from dark colored pavements raises localized temperatures, increases energy consumed to cool buildings and associated green house gas emissions, deteriorates air quality, and may harm humans, plant life and animal life sensitive to increased temperatures; and

Whereas, hardscape management methods, such as tree planting, shading, and use of reflective paving materials, will contribute to decreasing the urban heat island effect, which can reduce the energy consumption of buildings;

Therefore, be it ordained by the commission of the state/city/jurisdiciton of _____, as follows:

Section 1. The recitals and findings in the preamble to the Act are adopted by reference and incorporated as if fully set forth in this section.

Section 2. Heat Island Effect

Intent: The requirements of this Act are intended to reduce the heat island effect from hardscapes in the state/cityjurisdiciton of _____ and to consequently reduce energy consumption and associated energy use for the buildings of the city.

Definitions:

Hardscape. Areas of a building site or roadways that are covered by manmade materials, such as roadways, parking lots, sidewalks, etc.
Heat island effect. Elevated temperature over an urban area when compared to rural areas, typically caused by the increased presence of dark, heat absorbing materials, such as asphalt and dark roofs, in urban areas.
Solar Reflectance. Fraction of solar energy reflected by a material.
Pervious Concrete. Hydraulic cement concrete with distributed, interconnected macroscopic voids that allows water to pass through the material with little resistance.

Applicability:
The provisions of this Act are applicable in all zoning designations throughout the city, except they shall not apply in R1 and R2, to newly constructed buildings and to replacement of greater than 50% of the site hardscape after the effective date of this Act. In addition, the provisions of this Act are applicable to all state and or city/jurisdiction-owned new roadways and all roadways being resurfaced or replaced.

Solar reflectance shall be determined as follows:

b. For all hardscape and roofing materials used to comply with Section 2, shall have a minimum solar reflectance when tested in accordance with ASTM E903 or ASTM E1918, tested with a portable reflectometer at near ambient conditions, or default values of solar reflectance for listed materials may be used without testing as follows:

Material	Solar Reflectance Index
New Gray Concrete	35
New White Concrete	86
Weathered White Concrete	45
Weathered Gray Concrete	19
Weathered Asphalt	6
New Asphalt	0

Requirements:
Building sites and state/cityjurisdiction owned roadways shall be required to comply with the following:

a. Provide any combination of the following strategies for fifty percent (50%) of the site or roadway hardscape:
    1. Shade from solar panels or roofing materials with a solar reflectance of at least 0.3.
    2. Shade from trees within five (5) years of occupancy.
    3. Paving materials with a solar reflectance index of at least 29.
    4. Pervious concrete pavement.

OR

b. Place a minimum of fifty-percent (50%) of parking spaces under cover (defined as underground, under deck, under roof, or under building). Any roof used to shade or cover parking must have a solar reflectance index of at least 29.

Section 3. If any section, part of section, paragraph, clause, phrase or word of this Act is declared invalid, the remaining provisions of this Act shall not be affected.

Section 4. This Act shall become effective thirty (30) days after approval its adoption and signature of the Governor/Mayor/Council.

_____
Signed