Concrete Technology

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Solar Reflectance of Concrete

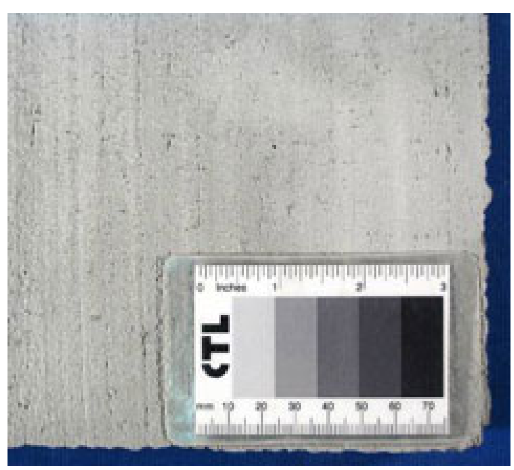
Concrete Shines as Solar Reflectance Material

Concrete does a very good job of reflecting solar energy. That is the finding from a recent PCA study which measured the solar reflectance of 135 concrete specimens from 45 mixes representing exterior concrete flatwork. In fact, all concretes tested in this study would qualify for LEED® credits for heat island effect reduction.

Solar reflectance index (SRI), a calculated value based on solar reflectance, SR, is one way to determine how much light energy a material reflects: stated another way, comparing SRI or SR of different materials tells which ones absorb less solar radiation. This is useful because darker materials absorb more heat, which is generally considered undesirable for its effect on the environment. This may have an immediate, local effect, like heat gain in urban areas (heat island).

In this study, the solar reflectance values of all 45 concretes tested are 0.33 and higher, corresponding to SRIs of 36 and higher. Solar reflectance is measured on a scale of 0 to 1: from not reflective to 100% reflective. Solar reflectance index, on a scale of 0 to 100 is the relative temperature of a surface with respect to standard white (SRI = 100) and standard black (SRI = 0) under the standard solar and ambient conditions. The average solar reflectance of all mixes studied is 0.47.

Of all the constituent materials, the solar reflectance of the portland cement itself has the greatest effect on concrete reflectance: the higher the cement reflectance, the higher the concrete reflectance. Two concretes had much higher average SRs of at least 0.64 (SRI = 78); one contained ordinary portland cement (gray) and a light-colored slag cement with crushed limestone fine aggregate; the other contained white portland cement and fine aggregate from crushed limestone.



CW-AL-CP-01: The code letters indicate concrete specimen made with white cement (CW), fine limestone aggregate (AL), coarse Eau Claire aggregate (CP), and the 01 indicates that this was specimen number 1 from that mix. Three specimens were made from each concrete mix.

CXB-AE-CP-FDG-01: The code letters indicate concrete specimen made with a gray cement (CXB), fine Eau Claire aggregate (AE), coarse Eau Claire aggregate (CP), dark gray fly ash (FDG), and the 01 indicates that this was specimen number 1 from that mix. Three specimens were made from each concrete mix.

Supplementary cementing materials (SCMs) can also be used as ingredients in concrete; after cement, SCMs have the next biggest effect on slab reflectance. Fly ash can have a greater or lesser SR than gray cement; slag has a greater SR than gray cement; and white cement in this study has the highest SR of all materials. The lowest SRs in this study are for concretes containing dark gray fly ash.

Fine aggregate was found to have a small, but significant, effect on slab reflectance, but coarse aggregate had no significant effect.

All slab specimens received a light broom finish, which was smoother or rougher depending on other concrete ingredients. (Finish was not measured, but was determined by visual assessment.) Smooth finishes reflect better than rough finishes.

LEED credits for reducing heat islands with concrete are possible in the two following areas: LEED-NC SS 7.1, Heat Island Effect: Non-Roof, and LEED NC SS 7.2, Heat Island Effect: Roof for Steep Sloped Roofs.

For a detailed report describing test procedures, concrete mixes, materials, and other aspects of this study, see PCA's SN2982, *Solar Reflectance of Concretes for LEED Sustainable Sites Credit: Heat Island Effect*. Authored by Medgar L. Marceau and Martha G. VanGeem.