

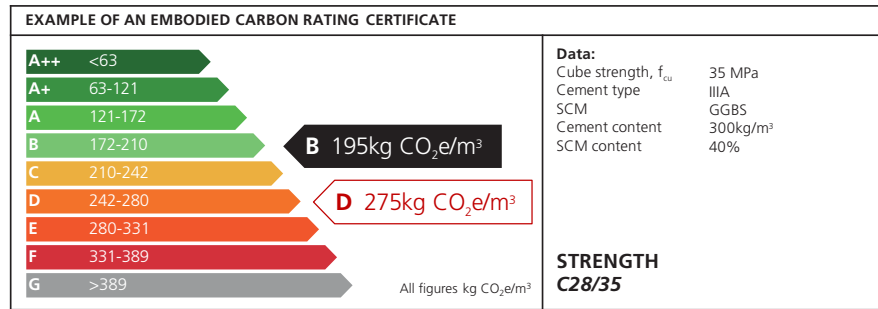
EMC Volcanics: Embodied Carbon Ratings

■ Empowering California's push for low-carbon concrete innovation ■

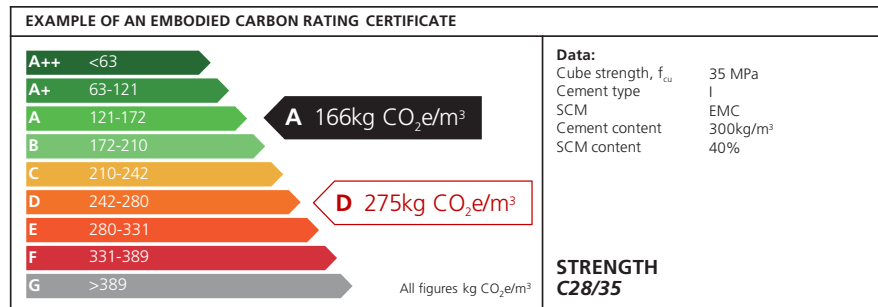
Preliminary Information and Examples.

EMC Volcanics qualify as supplementary cementitious materials ("SCMs") to reduce the embodied energy and carbon tallies in both concretes and mortars. [This document helps to show how.](#) All examples below use the color boundaries and layout per the I.C.E.'s "Low Carbon Routemap" ([here](#)). In common with the Low Carbon Routemap, EPDs, and Calgreen's recent code innovations ([here](#)), the embodied carbon is expressed in kg-CO₂ per cubic meter (m³) of concrete, across LCA zones A1–A3 inclusively. In all treatments, I.C.E. data is used for the embodied CO₂ content of CEM I/Type 1 cement, more commonly known as Ordinary Portland Cement ("OPC"). This is rated at 915 kgs-CO₂/metric tonne ("MT"). This may be highly conservative. For example, Australia's EPiC database v.9 ([here](#)) rates OPC at 1,300 kgs-CO₂/MT. For EMC Volcanics, I.C.E.'s tally for aggregates is used (A1), plus a round-trip of 20 miles for the delivery of raw materials, using the U.S. truck average of 161.8g CO₂ per ton-mile (A2). Finally, zero carbon EMC Technology is low-energy and all-electric, for which we assume 100% renewable electricity for production purposes (A3).

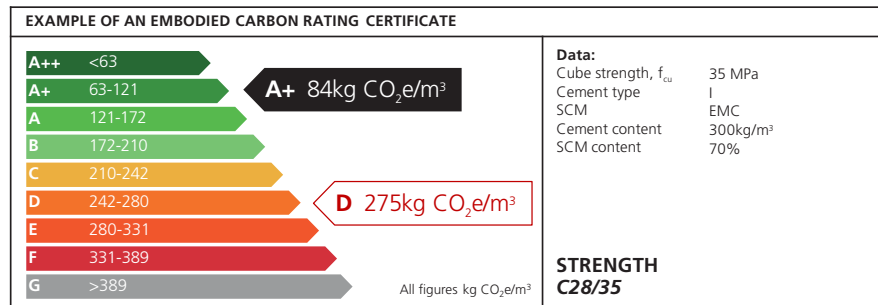
The first three examples use the norms per EN 206's Table F ([here](#)). The next page then develops the same approach into a Caltrans setting using its 2023 standard specifications ("Caltrans-23"). In all stated cement dosages, the purely OPC equivalent is stated **in red** for [easy visual comparison](#).



Example 1: An example from the Low Carbon Routemap. C28/35 is reinforced concrete intended for "moderate" exposure conditions. It requires a 28-day strength of 28 MPa (cylinder)/35 MPa (cube). The example uses CEM IIIA, which is a blended cement containing SCMs. Per EN-197, if slag is used, up to 65% of the OPC can be substituted. Here, slag is substituting 40% of the total cement's OPC dosage. At a total cement dosage of 300 kilos per m³, the embodied CO₂ is rated at 195kg/m³. Using 100% OPC at the same cement dosage, the CO₂ rating would be 275kg/m³ instead.



Example 2: At the same dosage and OPC substitution as **Example 1**, EMC Volcanics deliver a carbon improvement of ~30kg/m³ over **Example 1**.



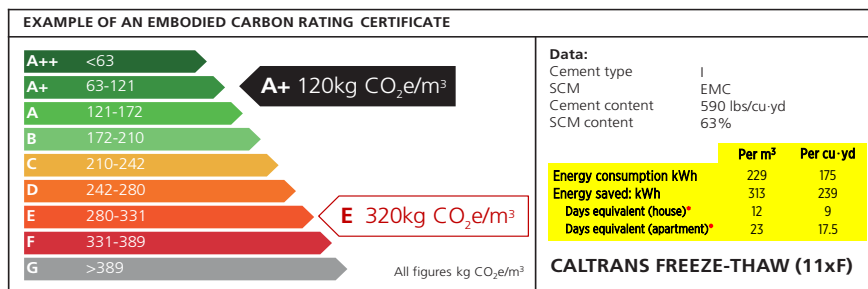
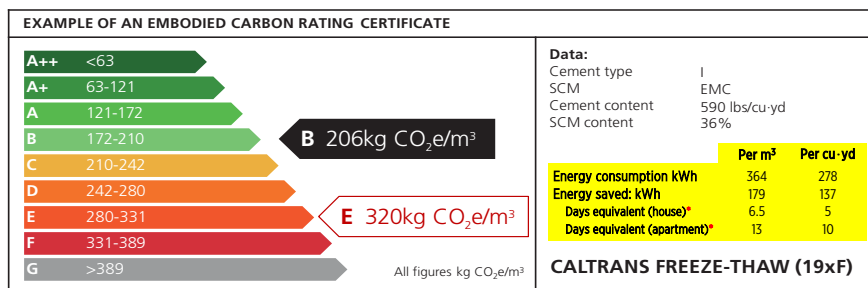
Example 3: At the same dose as **Examples 1 & 2**, but increasing the OPC substitution to 70%, **EMC Volcanics deliver a rating of only 84kg/m³!**



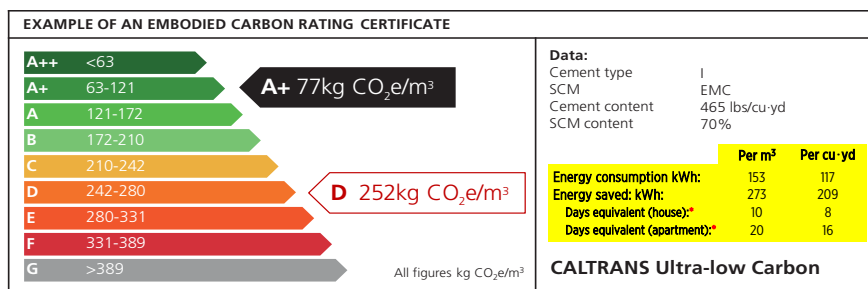
Caltrans 2023 Specifications.

Caltrans-23 does not specify minimum strength-developments and it rarely requires minimum cement dosages. Two exceptions are freeze-thaw concretes and those "in corrosive environments", to comprise respective minimums of 590lbs/cu-yd (§90-1.02I) and 675lbs/cu-yd (§90-1.02H). Per its §90-1.01D(5)(a), there are two general rules for strength development. **First**, for concretes with a 28-day strength "greater than 3,600 psi, 42 days are allowed to attain the strength described". **Second**, 56 days "are allowed to meet the required strength", where the SCM ratio is above a formulaic ratio depending on the SCMs used. For 100% volcanics, this requirement is met at ~40% OPC substitution upwards. Further, per §90-1.01D(5)(b), there is no "pre-qualification" requirement if the 28-day strength requirement is less than 3,600 psi. **These features favor low-carbon innovation.**

The examples below follow Caltrans-23's requirements. Again, the pure-OPC dosed concrete is stated in red. As further insight, the energy used is set-out on both a per m³ and cu-yd basis, together with the associated energy-savings when stacked against a pure-OPC counterpart. For OPC, we use I.C.E. data rated at 1,530 kWh/MT. This may be highly conservative. For example, Australia's latest EPIC database rates OPC at 11.8 GJ/MT (3,277 kWh/MT). By comparison, EMCs require about 120 kWh/MT, which have been increased to 150kWh/MT here in order to cover the energy requirement for raw material production, again using the I.C.E.'s figures for aggregates. Using California's stated metrics, the energy-savings are then expressed as a "days equivalent" measure of an average Californian household's and apartment's daily energy usage.



Examples 4 & 5: Both are for freeze-thaw environments, meeting Caltrans-23's minimum cement dosage of 590lbs/cu-yd. Volcanic SCMs cannot replace OPC by more than 36% (per **Example 4**). However, slags may replace OPC by 63% (per **Example 5**). EMC Volcanics can offer the same performance as slag. The two examples demonstrate the enhanced savings by allowing EMC Volcanics the same replacement-ceiling as slags.



Example 6: This is equivalent to a cement dosage of 275 kilos per m³, delivering a strength-class that, in context, accounts for 90-95% of all ready mix sales in the United Kingdom. At 70% OPC replacement, EMC Volcanics will easily deliver 3,600 psi strength by 56 days at this dosage, to also meet any 28-day pre-qualification need if adequately stipulated. As can be seen, **EMC Volcanics deliver a carbon rating of only 77 kg/m³!**

■ See: www.lowcarbocement.com ■

Prepared By EMC Cement BV

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Unless stated otherwise, "tons" means U.S. short tons; "tonnes" means metric tons.

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