



EMC Cement

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BY EMAIL ONLY
(hyperlinks below in blue)

September 4, 2023

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Placing SB596's Aims within California's Reach

Dear Addressees:

We wrote you on May 29, 2023, some two days before your second workshop geared towards resolving the required policy for SB596, by which per your scoping plan 2022 ([here](#)), CARB must develop "a comprehensive strategy by July 1, 2023, for the state's cement sector to achieve net-zero emissions of GHGs associated with cement used within the state as soon as possible, but no later than December 31, 2045". We had written you upon our receiving an unsolicited outreach by LACI of whom CARB is a partner. That letter was written further to our earlier letter dated June 22, 2022 (PDF [here](#)) confirming our desire to deliver competitive standard-compliant zero-carbon volcanic cements ("EMC Volcanics") made in California.

Introduction

SB 596 is a statutory requirement carrying the force of law. In that statutory context, this letter is sent as a letter of record to supplement our earlier letters. This letter will be copied also to various *dramatis personae* including Caltrans, Arup, SEAOSC (Structural Engineers Association of California) and those whom went on the record to support 2022's SB778. In preparing what follows, we have read the responses ([here](#)) of stakeholder invitees who made presentations at your two SB596 workshops. We note also the CalGreen building code ("Calgreen") innovations dated August 1, 2023 ([here](#)) that impose *embodied carbon* limits on the concrete poured in large building projects. In such regards, we have noted also the comments made by SEAOSC and Arup (PDF [here](#), at pp.12–13), both of whom appear to consider Calgreen's GWP thresholds to be disappointing: [▲]

TABLE 5.409.3: PRODUCT GWP LIMITS

Concrete Product Category	Maximum GWP allowed value in kg CO2e/m ³	
	Concrete, Ready-Mixed ^{2,3}	Concrete, Lightweight Ready-Mixed ²
up to 2499 psi	450	875
2500-3499 psi	489	956
3500-4499 psi	566	1,039
4500-5499 psi	661	—
5500-6499 psi	701	—
>6499 psi	799	—

[▲] See, resp., <https://www.seaosc.org/> and <https://www.arup.com/>

Footnotes:

² For concrete, 175% of the National Ready Mix Concrete Association (NRMCA) 2022 v.3 Pacific Southwest regional benchmark values [PDF [here](#)] are used for the GWP allowed, except for High Early strength.

³ Concrete High Early Strength ready-mixed shall be calculated at 130% of the Ready mixed concrete GWP allowed values for each product category.

Insight

"Should even a fraction of the new infrastructure projects detailed in this report go forward, it is likely that domestic cement demand may even grow rapidly in the short term and in excess of the 180mn T/yr projected for 2050. The proposed cement industry transition does not take into account additional demand growth arising from a massive buildout of new infrastructure in the United States. Accordingly, we may be underestimating the capacity needed to service future U.S. domestic cement demand in any deep decarbonization scenario."

Net-Zero America study, Annex K: Cement Industry Transition, Princeton University (2021), p.14 ([here](#))

The same concerns as above have been voiced also in California (*see, [here](#)*), such that we must conclude public awareness is real. To wit, Calgreen's term "GWP" is synonymous with an embodied carbon tally that must be stated by project suppliers in the form of Type III EPDs, in respect of which, "Updated EPDs for products used in construction shall be provided to the owner at the close of construction and to the enforcement entity upon request." We strongly welcome this measure, as it places EPDs onto a mandatory footing in tandem with LCA scoring. However, per the record, with reference to those GWP targets above, Arup noted that the Calgreen measures "are not sufficiently ambitious to leverage current industry capabilities and align with California's overall climate change strategy". We go further. While we broadly agree with the sentiments expressed by SEAOSC and Arup, we consider CalGreen to be largely otiose when stacked against SB596's legal needs. Nevertheless, Calgreen's GWP limits are interesting from at least two perspectives when compared to Europe:

- Unlike in Europe (*see, for ex., EN 206 Table F, PDF [here](#)*), Calgreen's GWP rules do not seek *in tandem* to also impose minimum total cementitious dosages into the concrete mix. Notionally, this means there is a "free floor" by which market participants will be free to aggressively reduce a concrete's embodied carbon tally.
- Calgreen's LCA requirements reference the latest Euronorm EN15804+A2, by which, because "cements" are "intermediate" products (*i.e.*, "physically integrated with other products during installation so they cannot be physically separated from them at end of life", plus other factors), an EPD is to be declared across LCA categories A1 to A3 only. This reduced need lowers the compliance costs for cementitious suppliers.

Innovators seeking project approval will also be required to deliver EPDs by law. All told, while there is little prospect for greenwashing or for wild or dubious technological claims, LCA compliance costs for cement suppliers are reduced. Further, minimum cementitious doses appear to be *decoupled* from strength-classes and their respective GWP limits. We welcome these innovations.

Why We Are Writing: History Must Not Repeat Itself

All-electric low-energy zero-CO₂ EMC Technology is truly transformative. Making EMC Volcanics available in key markets within California is a surefire way by which to meet SB596. We have a long history of an association with California. Our documented Californian work helped found our EMC Volcanics USPTO patent (short movie, [here](#)). EMC Technology is TRL 9 ready.

With support, we can start to deliver the embodied carbon reductions that will fully align with SB596's requirements. California's concrete can be decarbonized by 2030 to achieve net zero via OPC's high-level substitution using SCMs. As the next section makes clear, history must not repeat.

Prior Californian Experience of Our Trying to "Shift the Dial"

12 "So far and on a global average, the volumes of cement being produced with natural and natural
13 calcined pozzolans is rather low. However, due to their good availability, their lower CO₂
14 footprint as compared to clinker and their very good contribution to cement performance, these
15 materials will have a great potential to replace granulated blast furnace slag and fly ash as well
16 as clinker in future clinker-efficient composite cements."

State of the Art Cement Manufacture: Current Technologies & Future Development, ECRA (2022), p.19 ([here](#))

These recent findings state the wisdom of the Portland cement ("OPC") industry's own research thinktank in Europe ([here](#)) having in mind that, ignoring China's OPC industry, the World's top-three largest OPC producers are European ([here](#)). While ECRA's words speak for themselves, it is trite to state that volcanic materials are abundant and particularly-so in California — indeed the entire Western U.S. Volcanic SCMs have featured in several of California's landmarks, including the Golden Gate Bridge. There is little excuse for not exploiting those natural SCM reserves other than a hitherto low OPC-replacement capability (typically at not more than 20%). EMC Technology solves this. 70% OPC substitution—without having to increase the cement dosage in the concrete mix—is our normal ([here](#)). In sum, EMC Volcanics deliver the performance of blast furnace slag with great workability, but without slag's crippling supply constraints. This opens-up the real prospect for a paradigm-shift taken by California in favor of volcanic SCMs, for a low-energy all-electric SCM transformation. Right now.

17 "Until a very low GHG emissions alternative binder to Portland cement is commercialised,
18 which does not look promising in the near to medium term, CCS will be essential for
19 eliminating the limestone calcination process emissions for making clinker, which currently
20 represent 60% of GHG emissions in best available technology plants."

Mitigation of Climate Change, IPCC Sixth Assessment Report (2022), WGIII, p.1164 ([here](#))

Standing in stark contrast to the words of ECRA, the IPCC's words state the collective wisdom of the World's climate scientists, as informed by industry and academia. While these words help impute the opportunity for EMC Volcanics to cause real "news" for the IPCC, it is also clear that technological CCS is seen by the IPCC as an adjunct "stop-gap" measure *until* OPC alternates are found. Per the separate enclosure, had Caltrans etc. not caved-in to the OPC industry's noted aggression back in 2008, the above IPCC excerpt would never have been written. California would have made history. The OPC industry's January 23, 2008 letter (which is a letter of public record) fully supported the introduction of SCM's into California in order to meet AB32's impetus, but, *that all changed* once the OPC industry learned that we could already deliver—at that stage of our developmental trajectory—a 50% OPC substitution using our volcanic SCMs. For the avoidance of doubt, please see the first paragraph of that 2008 OPC industry letter, at page 2:

21 "We are optimistic that a cement blending measure can be developed that meets the require-
22 ments of AB32, whereas the other cement measures under consideration are unlikely to meet
23 AB32 requirements. The use of supplementary cementitious materials (SCMs) in concrete
24 products is the best way to reduce GHG emissions from cement because, as SCM use increases
25 and cement requirements decrease, both process and fuel emissions are reduced."

The above excerpt bears witness as to how the OPC industry seemingly strongly supported the use of SCMs ("The use of supplementary cementitious materials (SCMs) in concrete products is the best way to reduce GHG emissions from cement because, as SCM use increases and cement requirements decrease, both process and fuel emissions are reduced"). Once the OPC Industry got to learn of our capabilities, it *then* pivoted 180-degrees to vociferously lobby *against* SCMs. In barely six months.

History must not be allowed to repeat itself. We have read the California OPC industry's letter of June 30, 2023 written to CARB ([here](#)), which helpfully states at page 4:

26 "The use of SCMs effectively reduces the share of clinker content and, as a result, reduces the
27 GHG footprint of the product. By expanding the definition of cement to include SCMs, CARB
28 would be recognizing, incentivizing, and accelerating the investments needed to produce lower-
29 emissions blended cements and bring them to market.
30 CARB will also need to specify what qualifies as an SCM. We recommend that the definition
31 explicitly mention supplementary cementitious materials that are commonly used today,
32 including granulated ground blast furnace slag; fly ash; natural pozzolans; calcined clays; and
33 silica fume. We also recommend that CARB establish a process that allows producers to petition
34 to add a new material to the list of SCMs that have the potential to reduce the clinker content
35 of cement without sacrificing product performance."

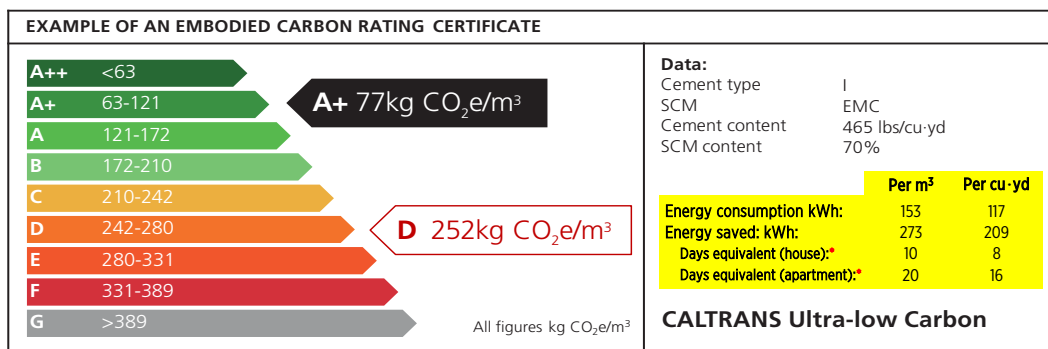
We support the OPC industry's statement. Further, with regards to "recarbonation" we note also that letter's pp.2-3, namely its useful reference to the earlier 2021-segment of IPCC's Sixth Assessment Report. However, forming *chalk* is not the only chemical pathway by which a concrete might recapture CO₂ across its lifetime. Volcanics also offer a *natural* CCS effect, which is much more powerful and does not form chalk. A 2017 monograph tested volcanic/OPC concretes, to conclude such concretes offer much-enhanced natural CCS the greater the OPC is substituted-out by volcanic materials ([here](#)). Hence, there is the real prospect that concretes using 70% EMC Volcanics will yield up to 3.5x the natural CCS effect of OPC concretes. This means by using lower cement dosages, there is then a real prospect for **net-negative concretes**. For example, based on our own U.K. data, we estimate 95% of the U.K.'s ready-mix needs can be served with concretes of 275kg/m³ total cement dosage comprising 70% EMC Volcanics. **Per the Annex**, that dosage will deliver an embodied CO₂ score of less than 80kg CO₂/m³ concrete. This is way below Calgreen's lowest GWP threshold. At that dose, there is a real prospect for a *net negative effect* across that concrete's lifetime (*see*, [here](#)). Calgreen's decoupling of strength-classes from minimum total-cement dosages means that the potential for a *net negative effect* can enhanced even further in California, provided always that key performance requirements are met.

Conclusion: Volcanic SCMs Are the "Best Shot" for Delivering SB596

36 (a) (1) By July 1, 2023, [CARB] shall develop a comprehensive strategy for the state's cement sector to
37 achieve net-zero emissions of greenhouse gases associated with cement used within the state as soon as
38 possible, but no later than December 31, 2045.
39 (b) In developing the comprehensive strategy pursuant to subdivision (a), [CARB] shall do all the
40 following:
41 (7) **Evaluate measures to support market demand and financial incentives** to encourage the production
42 and use of cement **with low greenhouse gas intensity**, including, but not limited to, consideration of all
43 the following measures:
44 (A) Measures to expedite the adoption for use in projects undertaken by state agencies, including the
45 Department of Transportation, of Portland limestone cement and other blended cements.*

* The statutory enactment of SB596 via CA Health & Safety Code §38561.2 ([here](#)).

California has a rich indelible history of using volcanic SCMs for its landmark structures. Its concrete suppliers know how to blend. However, technology is only effective if it can be broadly applied. There are many aspects to this challenge that EMC Technology can meet. Using TRL9 scalable low-energy zero-emissions technology—fed by California's own abundant standard-compliant volcanics—we can deliver standard-compliant cement for superb concretes of enhanced durability with enhanced natural CCS (the vast majority of which will carry a real prospect for a *net negative effect* across their lifetime). Embedding EMC Volcanics into California's evolving market will allow its participants to make their own choices in a carbon-driven compliance ecosystem that already is to require EPDs and LCA tallies in major projects, and where Calgreen's GWP scores appear to be fully *decoupled* from minimum total cement doses. The market will get to choose. We suggest this is surely the best shot for delivering the law's carbon reduction demands — and we stand ready to make that transformation happen. Right now.



Sample concrete-rating label per the United Kingdom's I.C.E. schema, synthesized using Caltrans-2023 Specifications (see Annex).

History must not be allowed to repeat itself. The Annex sets out the clear gains per Caltrans' 2023 specifications. The Capex for a fully-operational 1.5mn short ton EMC plant is only a minor fraction of an OPC plant of the same size. **The difference?** Ton-for-ton an energy saving in excess of 1.2 MWh, meeting the U.S. EIA's strategy for low energy electrification ([here](#)). **The difference?** Such an EMC plant will carry a certified CO₂ mitigation potential more than 1mn tonnes yearly. With coordination, this could directly feed into the United States' own Paris Accord Art.4 commitments.

We trust this letter has provided useful insight having in mind the law's requirements set out above, in respect of which we ask that this letter is taken into consideration. Hence, we give you permission to publish this letter in full. Finally, for further insight please visit: www.lowcarbocement.com.

We repeat our requests per our May 29, 2023 letter and look forward to hearing from you.

Sincerely

Atle Lygren
C.E.O. EMC Cement BV

ENC: EMC Volcanics: Embodied Carbon Ratings, Empowering California's push for low-carbon concrete innovation

Read more here:
WIKIPEDIA

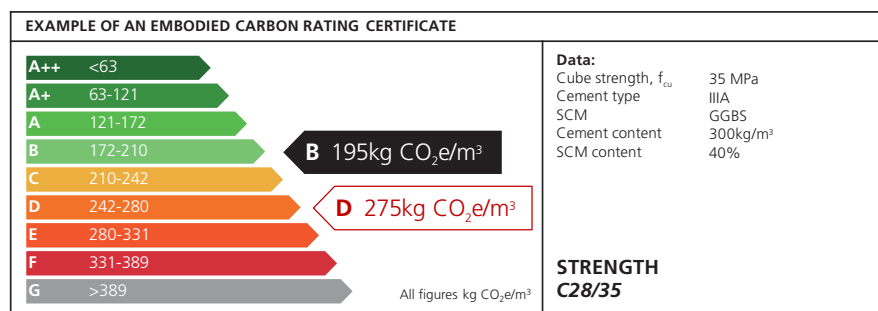
EMC Volcanics: Embodied Carbon Ratings

Empowering California's push for low-carbon concrete innovation

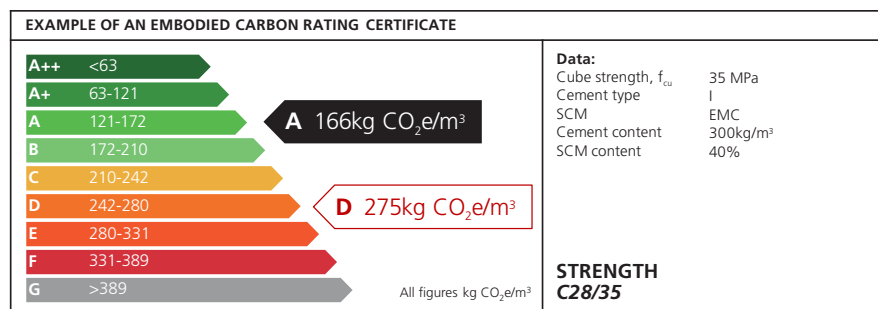
Preliminary Information and Examples.

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).

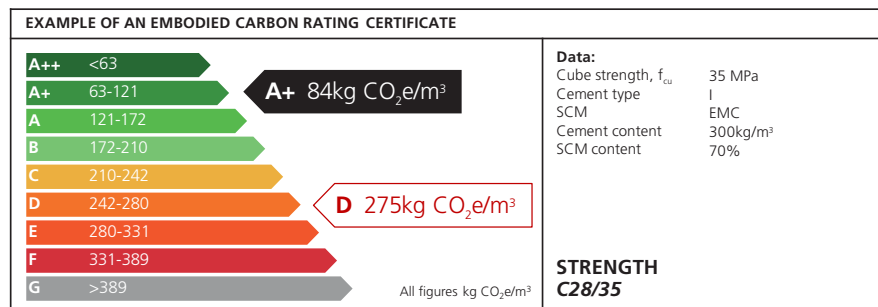
The first three examples use the norms per EN 206's Table F ([here](#)). The next page then develops the same approach into a Caltrans setting using its 2023 standard specifications ("Caltrans-23"). In all stated cement dosages, the purely OPC equivalent is stated **in red** for easy visual comparison.



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!**

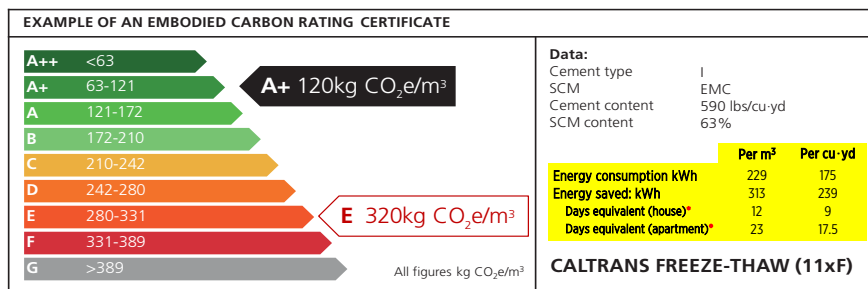
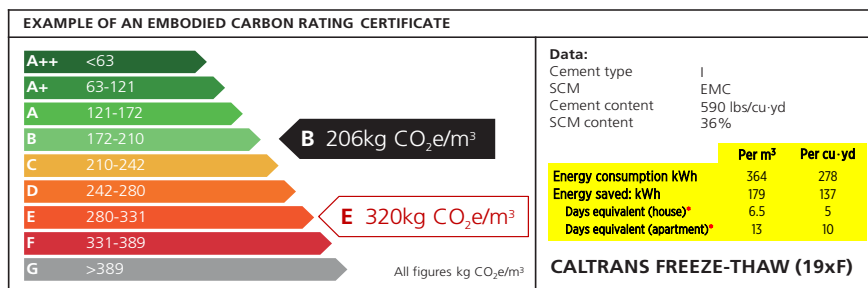


EMC Cement

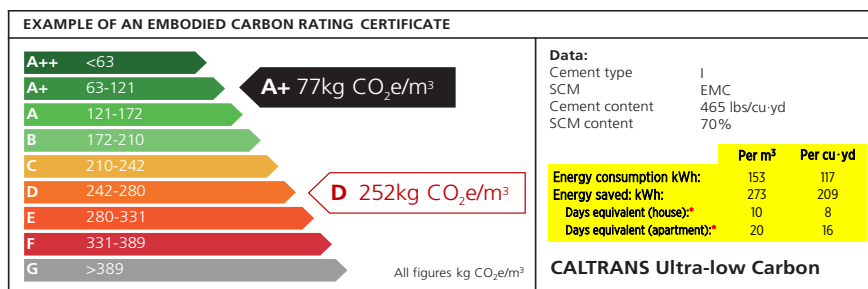
Caltrans 2023 Specifications.

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 ■

NOTE: The examples set out are for illustrative purposes only and are offered only as a reasonable approximation of EMC Volcanics' potential EPD scores, the precise value of which can and will be determined only upon actual production.