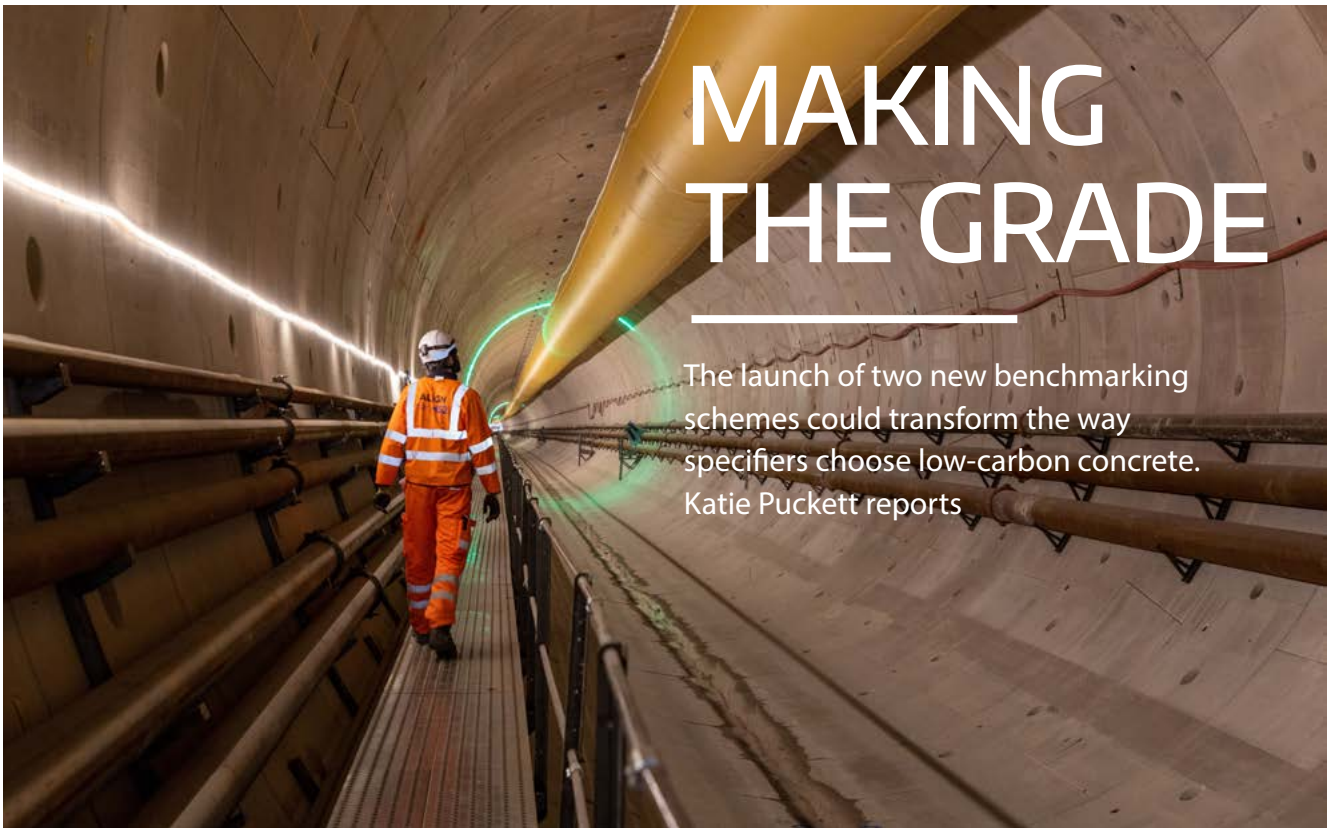


MAKING THE GRADE

The launch of two new benchmarking schemes could transform the way specifiers choose low-carbon concrete. Katie Puckett reports

Photo: HS2

THE CONCEPT

Why we need rating tools and how they work

Calculating the embodied carbon of concrete is complex because a mix may contain many potential ingredients in different proportions, depending on the job it is intended to do and where in the country it is sourced from. In the absence of an objective scale, the term "low-carbon concrete" has been applied to products with widely varying carbon footprints. This leaves specifiers in the dark, and makes it hard for manufacturers of genuinely lower-embodied carbon mixes to compete against cheaper products with a higher carbon footprint.

This is the problem that two new ratings schemes have been designed to solve, by grading products alphabetically, from A and B all the way down to F and G. The hope is that a standardised labelling system will support the market to make lower-carbon choices, and encourage suppliers to develop progressively better products. The two systems take different approaches to communicating the embodied carbon of concrete, and are useful for different things, but most valuable when combined. What unites them is an attempt to reflect a complex reality in a way that can be easily applied.

"There are lots of different opinions and everyone was saying different things," says Bruce Martin, associate director at Expedition Engineering and a member of the Green Construction Board's Low Carbon Concrete Group (LCCG). "So we were trying to find out what was available, and create a market benchmark to identify which were the lower and higher embodied carbon concretes."

The LCCG's benchmark, launched in April 2022, provides a dynamic snapshot of the current market, segmenting products into rating bands that will evolve over time. Bands A to E each represent 20% of concrete produced in the UK, while those in band F have higher embodied carbon than any of the concretes submitted to the LCCG. At the other end of the scale, concretes with a lower embodied carbon than any of the submitted concretes are labelled "market beating".

The first iteration was based on a relatively small dataset, but quickly demonstrated the value of the concept. An updated version, just released, is much more comprehensive, generated using data for around 50% of all the ready-mixed concrete produced in the UK during 2022, thanks to support from MPA and its members. To create the rating bands, this data was plotted on a graph, with the Eurocode strength classes along the x-axis, and embodied carbon along the y-axis.

Although there are many variables that influence the embodied carbon of concrete, strength is a useful metric as both a functional requirement and one that tends to correlate with the proportion of cement, which accounts for by far the greatest share of emissions. As the embodied carbon of available products comes down over time, the boundaries of the rating bands will shift and the curves should become gradually shallower. The

latest version further breaks down each of the rating bands into four – ie, A1, A2, A3, A4 – each representing 5% of the market, and providing an additional incentive to improve, even if it's not feasible to jump a whole band.

This dynamic approach is very useful for showing the relative carbon content of different products, and for setting deliverable targets on current projects. But for setting longer-term targets and illustrating progress towards net-zero, it's necessary to have a static benchmark. This is where the scheme developed by Arup with funding from Innovate UK comes in.

This combines real-world data on mixes with higher embodied carbon and statistical analysis to set a conservative baseline, and rating bands at 20% intervals, scaling down to zero and beyond. A G-rated concrete has higher embodied carbon than the current market, a B-rated concrete has embodied carbon 80-100% lower than the baseline, and an A-rated concrete is carbon-negative.

"What's happening in the industry is not necessarily where we need to be heading, as the evolution may not be as fast as we anticipated in terms of technology development," says Dr Fragkoulis Kanavaris, a materials specialist at Arup. "So if we plot the dynamic LCCG data within a static scheme that's the same over time, we'll be able to see how we are progressing."

The scheme is deliberately technology agnostic, and doesn't distinguish between different types of concrete or their intended function – as with the LCCG benchmark, products are characterised only by their compressive strength. "It would be easy to get lost in the details, but if we want to have a standardised scheme it needs to be as user-friendly as possible," explains Kanavaris. "That's very important because we have to satisfy a big spectrum of potential users across the value chain, from clients, policymakers and government bodies, to structural engineers, materials engineers, infrastructure owners and concrete producers."

> "IF WE WANT TO HAVE A STANDARDISED SCHEME, IT NEEDS TO BE AS USER-FRIENDLY AS POSSIBLE"

If the LCCG's greatest challenge was to collect sufficient data to create a true reflection of reality, one of the biggest concerns for the Arup team was designing the system so that it didn't skew the market in unhelpful ways. He highlights several areas where further data would be valuable for avoiding unintended consequences.

For example, both benchmarks focus only on project lifecycle stages A1 to A3, covering the supply and transport of raw materials and the manufacturing process – so cradle-to-factory gate for ready-mixed concrete, or cradle-to-mould for precast. Within this scope, precast concrete typically has a higher embodied carbon than in-situ because mixes are designed for earlier strength gain. "But there are other benefits of precast that can't be encapsulated in a classification scheme that is limited to the A1 to A3 stages," says Kanavaris. Neither can it take account of resource efficiency: "If an A-grade concrete is selected over a C-grade, but twice the volume used for a particular element, that's a potential misuse of the scheme."

For the future, both teams hope to incorporate more granular information about how, where and which concretes are specified. The latest version of the LCCG benchmark includes supplementary data on the total production of volume of different mixes, for example, and the embodied carbon of concrete used in different elements, and in different locations. This is still at an early stage, but Martin hopes that greater collection, particularly from contractors on how concretes are used, will create an increasingly comprehensive picture of the market with each update.

The two teams are now focusing on how the two systems can complement each other best. When the latest LCCG data is plotted on top of the Arup graph, the average rating broadly follows the boundary between the Arup ratings D and E, representing a 40% reduction in embodied carbon against the baseline. Accelerating change to bring this down to

Photo: Environment Agency

Opposite HS2 is among the major infrastructure clients working to develop a coordinated approach to applying the two rating tools

Right The Environment Agency is also playing a leading role in establishing the rating tools. At the Hexham Flood Alleviation Scheme, it has successfully trialled the use of two ultra low carbon C32/40 mixes, developed by Tarmac

zero or below is the ultimate goal for both.

"Our dynamic benchmark is useful to see how the concrete you're procuring or producing compares against the market and to push your supply chain," says Martin. "Then you can use the static scheme to tell them where you want to get to in five or ten years' time. They do very different things, but work very powerfully together."

"THE TWO SCHEMES DO VERY DIFFERENT THINGS, BUT WORK VERY POWERFULLY TOGETHER"

THE APPLICATION
How clients are using rating tools to reduce their carbon impact

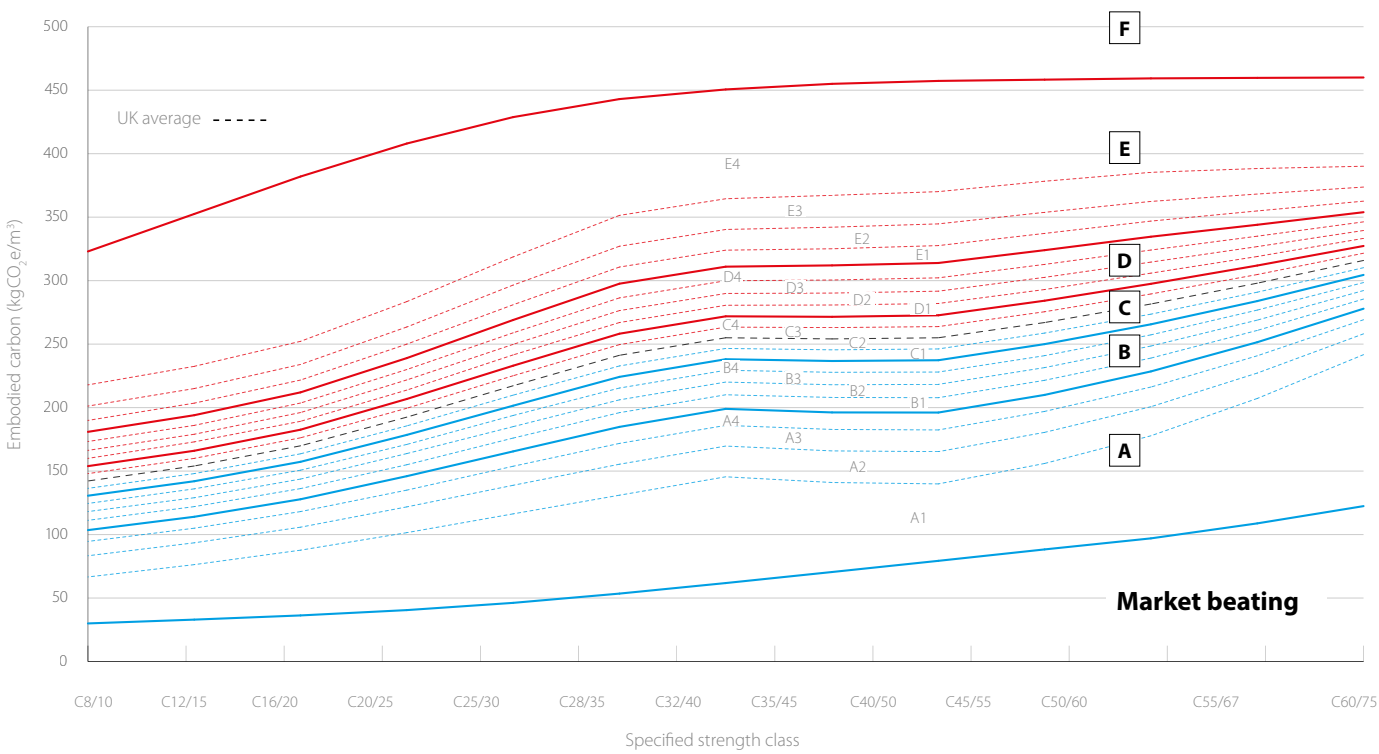
When the Low Carbon Concrete Group's embodied carbon benchmark was released in April 2022, it wasn't a novel concept for Andy Powell at the Environment Agency. The agency had already set its own carbon caps for the concrete used on its projects. The new benchmark did, however, make him reevaluate both its approach and the targets themselves.

"We didn't really have enough data to put together something really accurate, and the benchmark system is much more refined in terms of the different strength classes," says Powell, who leads the EA's national engineering innovation team. "We also realised that our caps were higher than they ought to be, and it gave us the confidence to work with our delivery partners to set tougher limits. It wasn't a difficult conversation about what was possible: we know it's possible because the data shows it's happening."

Since then, the Environment Agency has been working with other major infrastructure clients, including HS2 and Transport for London, to develop a coordinated approach to applying both the LCCG benchmark, and the complementary one released by Arup in June. "Each client will have slightly different drivers. But if we're all striving to decarbonise from where we are, that will send a clear, understandable message to the market and drive it forwards," says Powell. "If enough of us are specifying at the better end, that will drive the boundaries lower."

Taking a collaborative approach not only provides consistency for the supply chain, it also enables individual organisations to pool their influence. Transport for London, for example, is a relative minnow in terms of its concrete consumption. "We realised that working alone, we won't have as big an impact," says Jane Wright, a systems engineer working on its decarbonisation strategy. "If we're all working as a block, we're sending a clear signal to

Fig 1: LCCG market benchmark for embodied carbon, normal weight concrete, LCA stages A1-A3
(Readymix: cradle to batching plant gate. Precast: cradle to mould)



the market about where we want to go."

HS2, meanwhile, already has a target to halve the embodied carbon of its concrete and steel by 2030, says Jon Knights, lead materials engineer on the high-speed rail project. "Of nearly 200 mixes, more than 90% contain SCMs and 50% contain very high levels of replacement, so the bar is quite high already. That means we've got a lot of work to do to reduce it further."

All three organisations propose to set a minimum requirement of a B rating under the LCCG market benchmark, which means that only concrete with embodied carbon in the best 40% of the market should be used on their projects. This is a pragmatic decision, based on what's attainable: as public-sector bodies building essential infrastructure, they have to balance carbon with deliverability and cost, points out Knights. "On HS2, we have contractors trialling very low embodied carbon concretes containing alkali-activated cement. But as it stands, that type of technology is not a volume player."

What's possible will differ for each client, depending on what exactly is being constructed and their priorities at the time. On certain building elements, where strength or curing time is less important, it might be possible to do much better. "If there's a concrete that is A-rated or market-beating and it's suitable for the application and it's the best option, then we absolutely want designers to suggest that," says Wright.

"WE'RE NOT SAYING THAT THERE'S A PARTICULAR MATERIAL THAT YOU SHOULD BE USING. WE'RE FOCUSING ON THE OUTCOME"

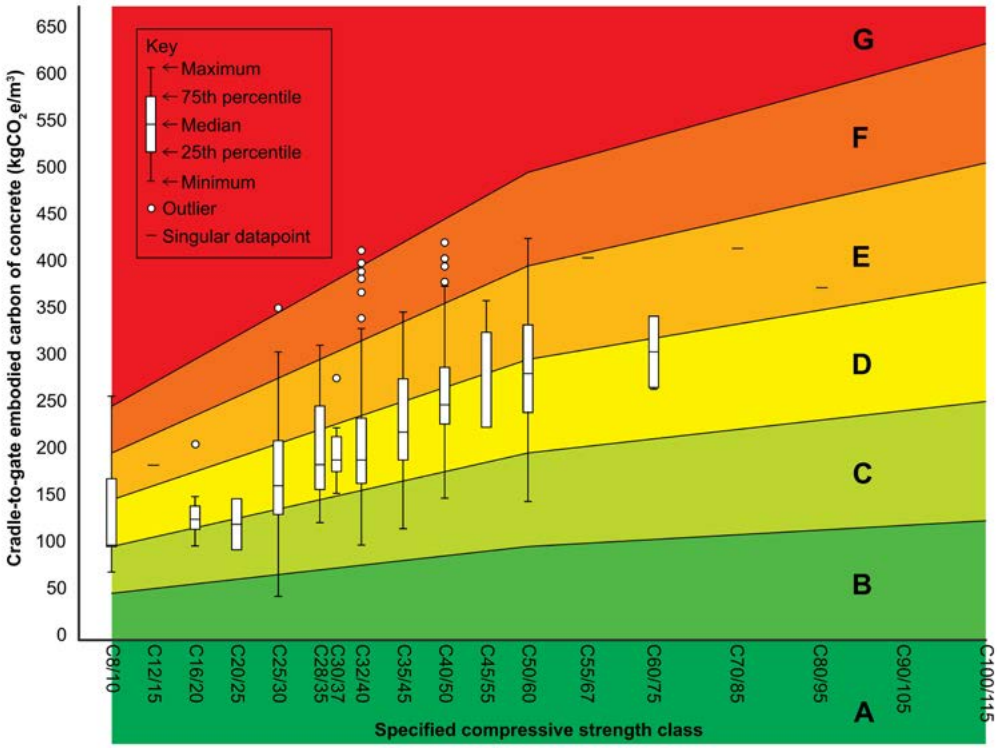


Fig 2: The Arup static rating scheme, with industry data from the LCCG 2023 benchmark mapped onto it to show the embodied carbon of commercially available concrete

She is also keen to emphasise that designers should focus on a whole-life analysis, before getting into the details of material specification. For example, it might be more resource-efficient to specify a smaller amount of a stronger mix. "It's not just about the concrete, it's about the whole design," agrees Knights. "We want to reduce the CO_2 generated in the production of Portland cement clinker, we want to reduce the amount of clinker in our concretes, and we want to reduce the total amounts of cement and of concrete. One way to do that is performance-based design, and taking a holistic approach."

The more important thing is that the industry adopts a standardised way of measuring and reporting embodied carbon. This is what they are currently focusing on, working with MPA to develop a consistent structure that will feed back into the benchmark to refine future iterations. "We have a project carbon calculator, but the challenge for us is to pull out one material type," says Powell. "And depending on when you decide to report, you might be cutting across a whole load of different projects at different stages, so that's something we need to work through."

Like HS2, the Environment Agency is trialling newer mixes and using the performance-by-testing approach to validate them. "But obviously that's relatively time-consuming and costly," says Powell. "The more novel materials are not scalable at the moment, but we have used A-rated blends of existing supplementary cementitious materials on one project, so we need those sorts of things to come through and land in the standards."

This ongoing innovation is why the benchmark rating system is so powerful, says Wright. "We're not saying that there's a particular material that you should be using. We're focusing on the outcome – lower-carbon concrete – but how we get there is an open playing field. It's really important that as clients we continue to support that work, so that we get to the low-carbon future that we're all striving for."

For more information, see "Embodied carbon of concrete – Market Benchmark", published by The Concrete Centre on behalf of the LCCG, or visit www.concretecentre.com/marketbenchmark