ROADSHOW REVIEW

THE LOW CARBON CONCRETE – DESIGN, SPECIFICATION & CONSTRUCTION MARCH 2025 ROADSHOW REVIEW

Concrete Institute of Australia held a national roadshow throughout March this year, bringing together three concrete sustainability experts to review the current status of designing and building with low carbon concrete.

It is widely recognised that concrete is responsible for a significant amount of carbon emissions due to the production process and the high volume of material consumed globally. As such, concrete plays a pivotal role towards sustainable construction and the circular economy throughout its entire life cycle.

The aim of the roadshow was to help concrete design, specification and construction professionals understand what is actually happening in the industry; how you can make a difference regardless of how big or small your organisation is; what the positive changes being made in the industry to lower carbon emissions are; what impact these changes may have to design, specification and construction; and how we can provide sustainable concrete solutions today and into the future.

The roadshow visited Brisbane, Sydney, Melbourne, Adelaide and Perth, with our speakers Warren South (Valkokivi), Clare Tubolets (SmartCrete CRC), and David Law (Aurecon) reviewing the different pathways available to reduce carbon content. Warren, Clare, and David talked about what progress has been made in these methods and analysed the techniques that can be used to reduce carbon and specify concrete to meet low carbon objectives.

WALKING THE PATHWAY TO DECARBONISATION

Presentation by Dr Warren South, Director of Valkokivi Pty Ltd and National President of the Concrete Institute of Australia.

In this presentation titled, Walking the Pathway to Decarbonisation, Dr Warren South outlined the steps and strategies for decarbonising the concrete industry, with an emphasis on concrete materials. The presentation was divided into key sections – product, specification, and reporting - each focusing on different aspects of the decarbonisation process.

The presentation began with an overview of the industry decarbonisation pathways document published in 2022, highlighting the importance of product composition and reporting. Dr South then delved into the specific actions that can be taken to achieve decarbonisation, such as the development of new and innovative products, increasing the limestone content in Type GP cement, and incorporating supplementary cementitious materials (SCMs) such as calcined clay cements and alkali-activated cements. He also emphasised the need for amending existing Standards such as including the recovery and beneficiation of fly ash and the addition of sustainability considerations in the National Building Code.

A significant portion of the presentation was dedicated to the adoption of global best practices in Codes, Standards, and specifications. The importance of material efficiency, developing options for SCMs, and supporting environmental product declarations (EPDs) was discussed and the presentation also addressed the challenges that still exist in the decarbonisation process.

In his presentation, Dr South highlighted the role of SCMs in concrete decarbonisation, noting that 20% of the planned reductions involve or require SCMs. He discussed the challenges for the current supply chain and future demand for SCMs, including the closure of coal-fired power generation and the migration to 'green steel' in iron and steel manufacturing. Dr South also noted the marked reduction in fly ash production capacity and the increased importation of slag to meet demand.

The future of SCMs was explored, with a focus on new regulatory frameworks to reduce the clinker factor across the supply chain and the development of new SCMs. Various materials were listed that can be used as SCMs, such as lithium by-products, calcined clays, and metakaolins. Dr South also discussed the potential of harvested coal combustion products (CCPs) as an untapped resource.

The presentation included a producer's view on the opportunities and challenges in the industry. Opportunities include greater utilisation of ash, economic opportunities within the circular economy framework, and alignment with sustainability initiatives. Challenges include the need for innovation to keep pace with industry developments, scalability and processing costs, and the timeline to market.

Also addressed were the directions in cement and binder development, including compliant materials, alkali-activated materials, and new binder systems designed to be used in modern building codes and standards.

The presentation continued with a discussion on the critical Australian Standards for concrete and the relationship between these Standards and specifications. The process of amending Standards was explained and then the importance of environmental product declarations (EPDs) in the decarbonisation process. The presentation also outlined a low-carbon concrete route map, with emphasis on the need for knowledge generation and transfer.

Overall, the presentation provided a comprehensive overview of the steps and strategies needed to achieve decarbonisation in the concrete industry, highlighting the importance of innovation, regulatory frameworks, and collaboration across the supply chain. Dr South's presentation concluded with a challenge to the audience to maintain a pro-active participation in the changing nature of cement and concrete.

DESIGNING AND SPECIFYING CONCRETE STRUCTURES FOR LOW-CARBON OUTCOMES

Presentation by David Law, Technical Director, Aurecon

"Design is so simple. That's why it is so complicated." - Paul Rand

We've all heard figures about the global carbon impact of concrete production. And we've all heard about the development and use of lower-carbon concretes as a material. But what role can design play in this issue? This article is an overview summary of what a design engineer should focus on, a few key tools and explanations, and the resulting impact this can have.

A DESIGNER'S IMPACT

The average Australian has a personal carbon footprint of around 15 tonnes CO_2-e per year. By taking some significant steps in our personal lives, like going vegan and not having a car, we could get this figure closer to 10-12 tonnes.

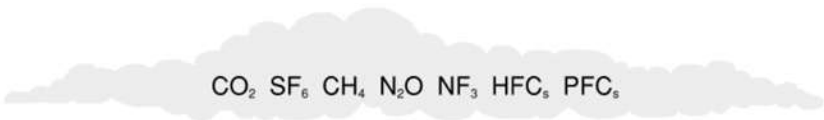
As a structural engineer, I've estimated that my professional carbon footprint and those of each of my colleagues, from the resulting material and construction emissions of the designs we produce, is around 800 tonnes CO_2-e per year.

Put simply, a design engineer's professional impact is 50+ times higher than their personal life. But so is their ability to make a difference – and those design carbon savings may be more readily achievable than you realise.

CALCULATING CARBON

Here are a few basics to start with for those getting up to speed.

"Carbon" in this context refers to a collection of Greenhouse Gas Emissions which all have a Global Warming Potential – **GWP**. For simplicity, we scale them all relative to their impact to create a measurement unite of carbon dioxide equivalent - **CO_2-e**. This is measured by mass, typically kg or tonnes.



Sources of greenhouse gas emissions from the production and use of materials are categorised and measured using a Lifecycle Assessment (LCA). This is worth researching if you're not familiar, but the key lesson for concrete and other long-lasting construction materials is that the upfront embodied carbon in stages A1-A5 is by far the largest and worth the most reduction effort.

Putting complexities aside, calculating the carbon impact of each material used can be summarised as the amount of material used multiplied by the carbon intensity figure of that material.

kg CO_2-e = volume of material (m^3, kg, etc) x kgCO_2-e/ volume of material

Hand calculation is possible, and an example is given below for reference. This is a simplified example for the purposes of design comparison, calculations can become much more complex when accurate verifiable assessments are required.

EMBODIED CARBON CALCULATION – WORKED EXAMPLE

1500mm wide x 600mm deep RC ground beams, 45m total length. 170 kg/m^3 reinforcement

Embodied Carbon = ∑(Material Quantity × Emission Factor)

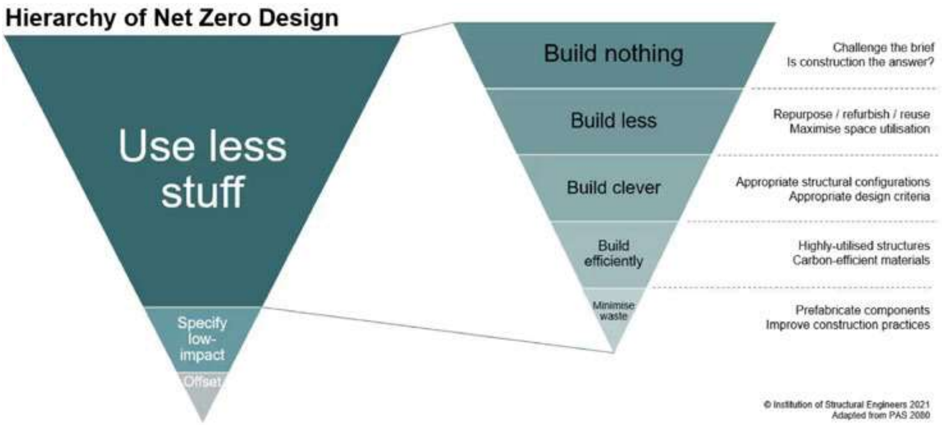
Concrete	Concrete = 1.5 x 0.6 x 45 = 41m^3
	Emission factor = 300 kgCO_2e/m^3 (taken from EPD or industry guide)
	Embodied Carbon (A1-A3) = 41m^3 x 300 kgCO_2e/m^3 = 12,300 kg CO_2e
	Concrete = 16,400 kgCO_2e (A1-A3)
Reinforcement	Rebar weight = 41m^3 x 170kg/m^3 = 7,000kg
	Emission factor = 1.6 kgCO_2e/kg (from EPD, includes recycled content)
	Embodied Carbon (A1-A3) = 7000kg x 1.6 kgCO_2e/kg = 11,200 kg CO_2e
	Reinforcement = 11,200 kgCO_2e (A1-A3)
Therefore	**TOTAL EMBODIED CARBON (A1-A3) = 16,400 + 11,200 = 27,600 kgCO_2e**

Various bespoke and proprietary tools are available now to automate these calculations. Remember, however, calculations tools are great, but informed design decisions are what is important.

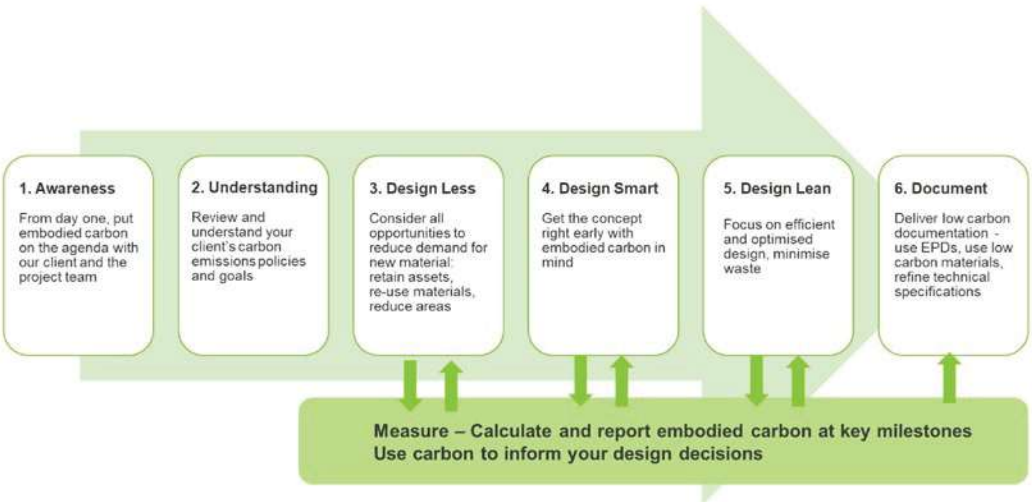
DESIGN PRINCIPLES

The calculation formulas give us two basic levers we could pull to reduce carbon. Materials science and supply chain solutions focus on the carbon intensity of concrete and every other material used. Design has the greatest power in focusing on the amount of material used.

There are many excellent guides now which detail out how to achieve material volume reduction for carbon outcomes. The one I find that best embodies and simplifies the principle is the Institution of Structural Engineers 'Hierarchy of Net Zero Design'.



There are two key elements to this approach. The first is that we set material use reduction as a clear and primary goal, and that low-carbon materials only follow after that. The second is that we achieve that material use reduction by starting with and prioritising big-picture thinking and working our way progressively down to the detail. As an engineer I have rationalised this into the following process to follow through a design timeline:



In the context of concrete compared with most construction materials, we need to bear in mind that it is a high-volume and relatively-lower-carbon-intensive material, and so significant volume savings are required with concrete to make a measurable difference.

SPECIFYING LOW CARBON CONCRETE MATERIAL

Once you have used design to minimise your volume of concrete and other material, I recommend a performance-based specification when specifying lower carbon concrete, rather than a prescriptive specification setting out what goes in the concrete mix. The advantages are:

- it allows the ready-mix supplier to use the 'best tools in their tool belt' to achieve the end product, for example, using whatever Supplementary Cementitious Materials (SCMs) are available
- emissions from all ready-mix production activities are taken into account including raw material production and transport
- the particular cement source and associated up-front carbon is included
- different geographical constraints can be taken into account, for example, the locally available aggregate may increase or decrease the cement demand.

A performance specification fundamentally only needs one key thing – a clear target. For concrete being supplied now in a large market where EPDs are available, I recommend directly specifying the end result we want - Maximum Global Warming Potential (GWP). Previously it was common to use SCM % – this is an indirect measure which provides inconsistent carbon reduction results, and in today's market it should only be needed when the supplier is not equipped to respond with GWP data. It should be measured in $kgCO_2e/m^3$ for concrete, as measured for modules A1 through A3 of a Life Cycle Assessment (LCA) for a supplier to respond to.

A commonly accepted way to specify a GWP target is to define the base case, (i.e. business-as-usual carbon intensity of materials in the current market) and a % reduction target. Government and industry guides and LCA/carbon tools are good guides for the base case and target, as is speaking to local concrete suppliers. Be sure that the figures used are appropriate for your region and concrete use.
An example specification clause is simply "The Global Warming Potential (GWP) of the specified concrete mix designs must be reduced by X% based on the standard base case". This could have individual targets set for each concrete mix used on the job, or a weighted average across the whole job to allow for some flexibility in supplier response.

Finally, a performance-based concrete specification should seek to remove the unintended barriers elsewhere in the document which inhibit low carbon outcomes – clauses which require higher performance than necessary in strength gain, cement quantity, water ratio, durability characteristics, slump, shrinkage and constituent material restrictions are all common. Integrity and performance are non-negotiable, but they don't need to be over-specified.

A PARTING THOUGHT

Concrete, and construction in general, could be viewed as wicked in the fight against carbon emissions and the climate crisis, due to its large contribution. But society still needs the critical infrastructure it produces. Design is our best tool to ensure we use concrete sparingly, appropriately and wisely – we have to treat every cube of concrete we use a carbon investment that must pay a return to society.

Author's footnote: Upfront carbon is just one of many environmental opportunities for improvement that a design engineer should consider, but also likely the biggest. Treat it as a good primary objective, but take the carbon blinkers off when you can.

SUSTAINABILITY: INNOVATION, POLICY AND LEGISLATION TO SUPPORT DECARBONISATION

Presentation by Clare Tubolets, Chief Executive Officer, SmartCrete CRC

With a decisive federal election result in early May, Australia has voted for stability in government and a continuation of existing priorities relating to cost of living, sustainability and economic resilience. In its first term, the Albanese government made significant commitments to Australia's sustainability agenda — most notably, bringing forward decarbonisation targets outlined in Australia's Nationally Determined Contributions under the international Paris Agreement framework. These targets have shaped the rollout of a series of legislative instruments and programs aimed at supporting Australia's transition to an emissions-neutral economy.

Over the past year, climate change policy teams across the Departments of Climate Change, Industry, Transport and Agriculture have worked collaboratively to engage deeply with industry and develop six sectoral net-zero plans. These plans aim to address sector-specific emissions while protecting and enhancing the resilience and productivity of each sector.

For the concrete sector, the Industry and Waste Sectoral Plan will be the most critical. It directly identifies cement and concrete as materials of interest and outlines priority pathways, including alternative and energy-efficient heat production, and carbon capture, use and storage (CCUS), as essential for meeting the 2035 emissions reduction targets. The full set of sectoral roadmaps is expected to be released soon and will likely also address lifecycle carbon measurement systems, demand-side interventions such as procurement policies, and strengthened regulatory frameworks.

Australia already has a clear process for carbon valuation. The Clean Energy Regulator facilitates a program to quantify Australian Carbon Credit Units (ACCUs), which assign a dollar value to each tonne of carbon dioxide equivalent. In November 2024, the Clean Energy Regulator reported that the ACCU price had risen to $42.50 — still relatively low compared to the global market. For instance, in 2024, the EU Emissions Trading System reported an average carbon price equivalent to AU $112.

Despite the lower price, the ACCU system remains a valuable mechanism that enables carbon to be factored into business decisions, encouraging more sustainable practices. Businesses can register carbon mitigation or abatement projects, which, once approved and completed, are awarded ACCUs. These can then be surrendered to the government at the prevailing price or traded with other businesses to offset emissions—offering direct financial benefits to participants.

As we approach the 2035 milestone for national decarbonisation and look further ahead to achieving net-zero by 2050, we can expect increasing interest, support and regulation around sustainability across government, industry and the community. The concrete sector has already laid strong foundations through the 2020 Decarbonisation Pathways for the Australian Cement and Concrete Sector report—a collaboration between SmartCrete CRC, Cement, Concrete and Aggregates Australia, and the Cement Industry Federation.

Progress has been made across the eight critical pathways identified in the report. These include increasing the use of supplementary cementitious materials (SCMs), optimising concrete use through improved engineering design, and developing innovative CCUS solutions. However, to truly accelerate this transformation, we must also address the market, policy and skills barriers that hinder the adoption of new products and systems.

Real progress toward a decarbonised concrete supply chain will require shared language and measurement systems, enhanced risk-sharing frameworks, harmonised procurement policies, robust knowledge and skills transfer platforms, and increased access to innovation investment. With a collaborative and systems-based approach, the Australian concrete sector is well positioned to become a global leader in supply chain innovation and decarbonisation.

SmartCrete Cooperative Research Centre is proud to continue supporting this critical work to underpin resilient concrete infrastructure for a sustainable Australian future.

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