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Low Carbon Concrete Pathways

Yarra Valley Water, North East Water, Barwon Water

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Prepared for/by

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Acknowledgment of Country

AECOM acknowledges the Traditional Custodians of country throughout Australia.

We pay our respects to both Elders past and present and to emerging community leaders. We recognise and celebrate the diversity of Aboriginal and Torres Strait Islander people and their ongoing cultures and connections to lands and waters.

Art by
Bianca Gardiner Dodd

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Abbreviations

Term	Definition	Term	Definition
BW	Barwon Water	MTM	Metro Trains Melbourne
CCTT	Cross Company Technical Taskforce	NEW	North East Water
CEC	Chemicals of Emerging Concern	OPC[1]	Ordinary Portland Cement
DTP	Department of Transport and Planning	PFA	Pulverised Fuel Ash (i.e. Fly ash)
EPD	Environmental Product Declaration	RCA	Recycled Concrete Aggregate
GBCA	Green Building Council of Australia	SCM	Supplementary Cementitious Materials
GGBS	Ground Granulated Blast-furnace Slag	SMART	Specific, Measurable, Achievable, Relevant, and Time-bound
GHG	Greenhouse gas	VIDA	Victorian Infrastructure Delivery Authority
GP[1]	General Purpose cement (in Australia typically contains 92.5% Ordinary Portland Cement blended with 7.5% ground limestone)	VPV	Volume of Permeable Voids
IPCC	Intergovernmental Panel on Climate Change	VR	VicRoads
MECLA	Materials and Embodied Carbon Leaders Alliance	WSAA	Water Services Association of Australia
MRWA	Melbourne Retail Water Agencies	YVW	Yarra Valley Water

Note: 1 – for the purpose of simplicity wherever the term 'cement' is used it can be taken as referring to either GP cement or ordinary Portland cement as the carbon differential is minimal.

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Introduction

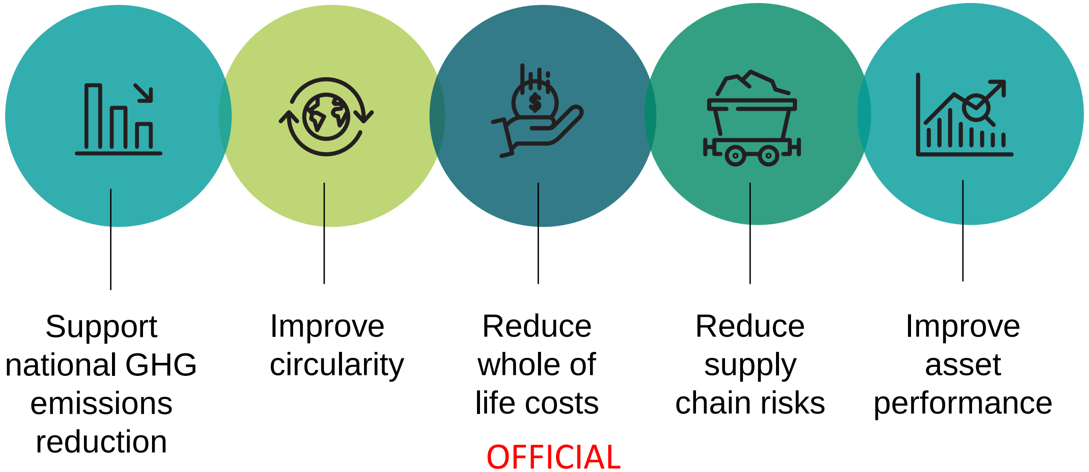
Introduction

AECOM has been engaged by Yarra Valley Water (YVW), North East Water (NEW) and Barwon Water (BW) to recommend low carbon concrete alternatives for water industry applications. The purpose of this document is to provide water sector professionals with a high-level understanding of **low carbon concrete pathways to reduce carbon emissions related to concrete** (herein referred to as concrete emissions as detailed on the next page) and **promote circularity**. The pathways and implementation tasks must be reviewed and adapted to the needs of the respective water corporation and may be used to inform the development of organisational strategies or processes/tools.

Human-induced climate change is causing irreversible damage to communities, the economy and the environment, and it is imperative that strong and sustained action is taken to limit its future impacts (IPCC, 2022). Greenhouse gas emissions (GHG) released into the atmosphere because of human activity have largely contributed to the global warming observed since 1950, based on the findings of the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (2023).

Up to 70% of Australia's annual emissions can be directly or indirectly attributed to the lifecycle of infrastructure, which can be classified as operational, enabled and embodied emissions (ISCA, 2023). Ordinary Portland cement (OPC) is a large contributor to this figure, estimated to be 8% globally. The Victorian water sector is a significant source of greenhouse gas emissions, contributing approximately 25% of the State Government's total emissions and approximately 1% of the State's total emissions (DEECA, 2024). The Victorian water sector has set world-leading targets to cut emissions to achieve net zero (scope 1 and 2) by 2035 (DEECA, 2024a), demonstrating leadership in reducing emissions faster than many other sectors.

Under the Corporations Act 2001, all water corporations will need to start scope 3 reporting by 2025. There is strong public support for emissions reduction in Victoria, and while the focus to reduce scope 1 and 2 will continue, scope 3 targets may follow. Water corporations need to understand, quantify and manage their scope 3 emissions to respond to the evolving regulatory and reporting environment, as well as stakeholder expectations. It is also an opportunity for the water sector to continue its leadership in emissions reduction and consider the benefits of adopting of low carbon concrete to:



Defining concrete emissions

A basic approach to defining carbon emissions related to concrete alone has been adopted for the purpose of this study and will be referred to herein as '**concrete emissions**', noting the following:

- A boundary approach in accordance with ***EN 17472:2022 Sustainability assessment of civil works - Calculations methods*** has been adopted. This means considering concrete emissions across the lifecycle stages set out in EN 17472:2022 notably: ***Product stage*** (A1-3), ***Construction process stage*** (A4-5), ***Use stage*** (B1-8) and ***End-of-life stage*** (C1-4) where these are applicable to the typical characteristics of concrete as illustrated in Figure 1.
- Like all other construction materials, concrete emissions fall under the category of **scope 3 emissions.** Scope 3 emissions are defined as ***all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions*** (GHG Protocol Scope 3 Standard).
- MECLA (2022) defines embodied carbon as the total greenhouse emissions generated during the manufacture of the materials and products used in the construction and refurbishment of new and existing buildings and infrastructure (2022). The definition of concrete emissions used in this study goes beyond the definition of embodied emissions to also include whole of lifecycle emissions as per ***EN 17472:2022.***
- Note that the performance achieved by suppliers is rarely evaluated on a like for like basis measurement, unless a consistent methodology is applied e.g., Environmental Product Declaration (EPD), hence caution should be used if attempting to compare materials.

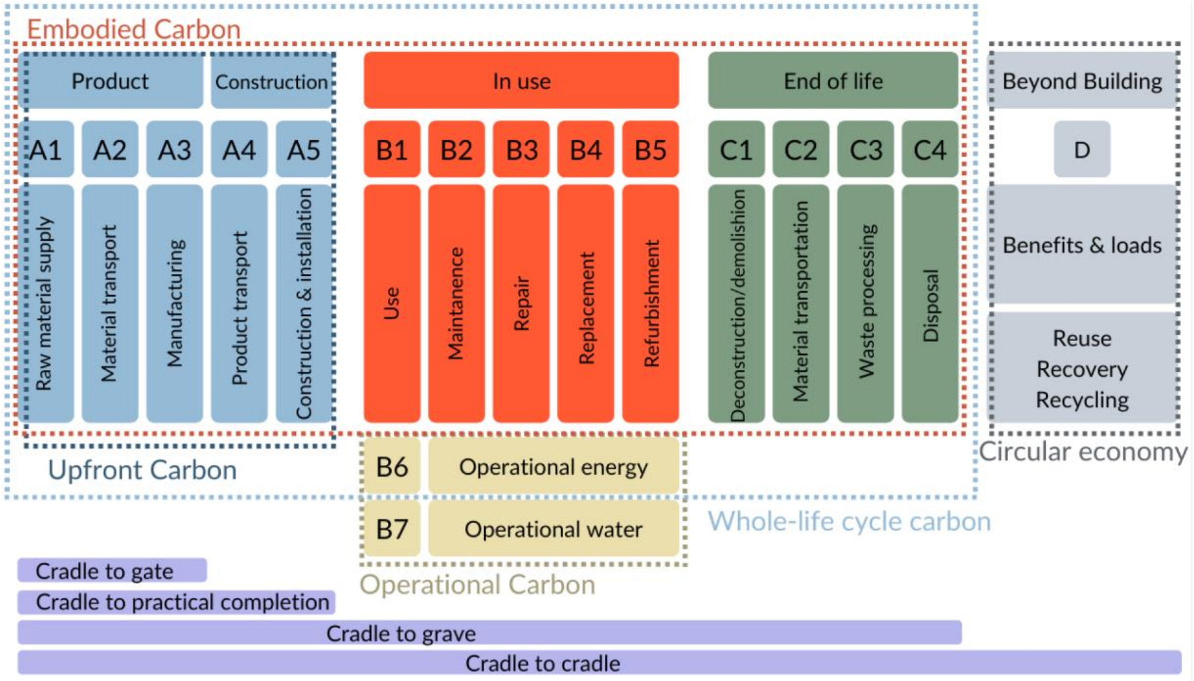


Figure 1: BS EN 15978:2011 Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method – European Standards (en-standard.eu) (amended to include whole-life cycle carbon)

How to use this document

For each recommendation, the following information has been provided:

Purpose

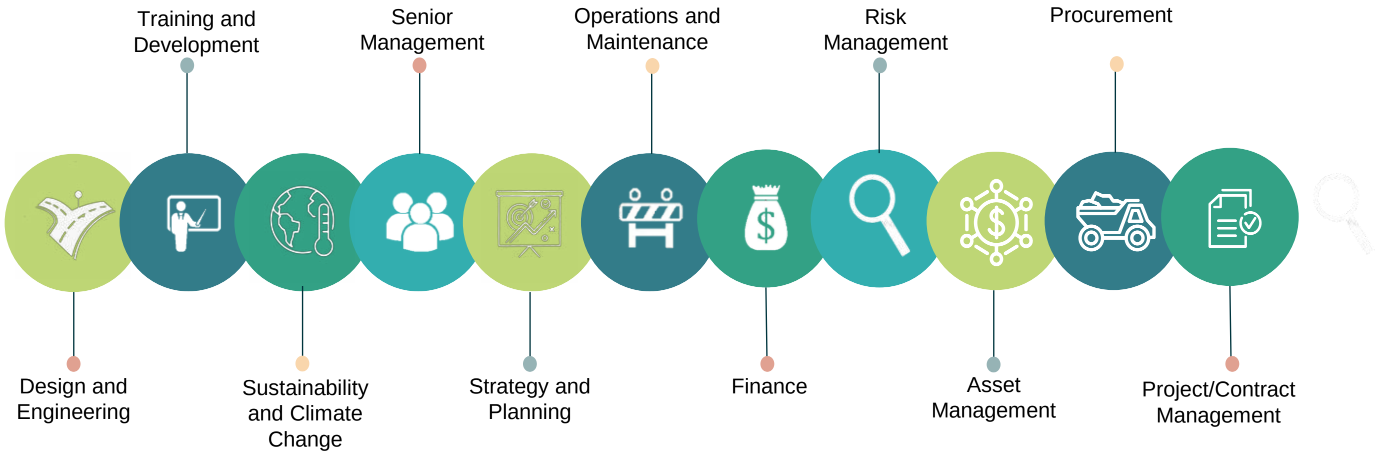
The motivation for implementing the recommendation

Outcome

Benefits of implementing the recommendation

Roles and responsibility

Roles/teams responsible for implementing the recommendation:



Implementation tasks

Key tasks required to implement the recommendation

Timing

Indicative timing for implementing the recommendation:

Why have a Decarbonisation Pathway for concrete?

1

The future **cost of carbon** will result in significant costs to all water utilities – reducing the concrete emissions in assets being built today will significantly **reduce offset costs** in the future. E.g., Scottish Water developed a business case to justify investment in low carbon concrete today to reduce the offset costs in the future.

2

Concrete suppliers cannot solve this alone -close **collaboration and planning is required across sectors** (e.g., Scottish water is collaborating with the power sector) to ensure that carbon reductions are maximised while maintaining technical requirements and minimising business risk.

3

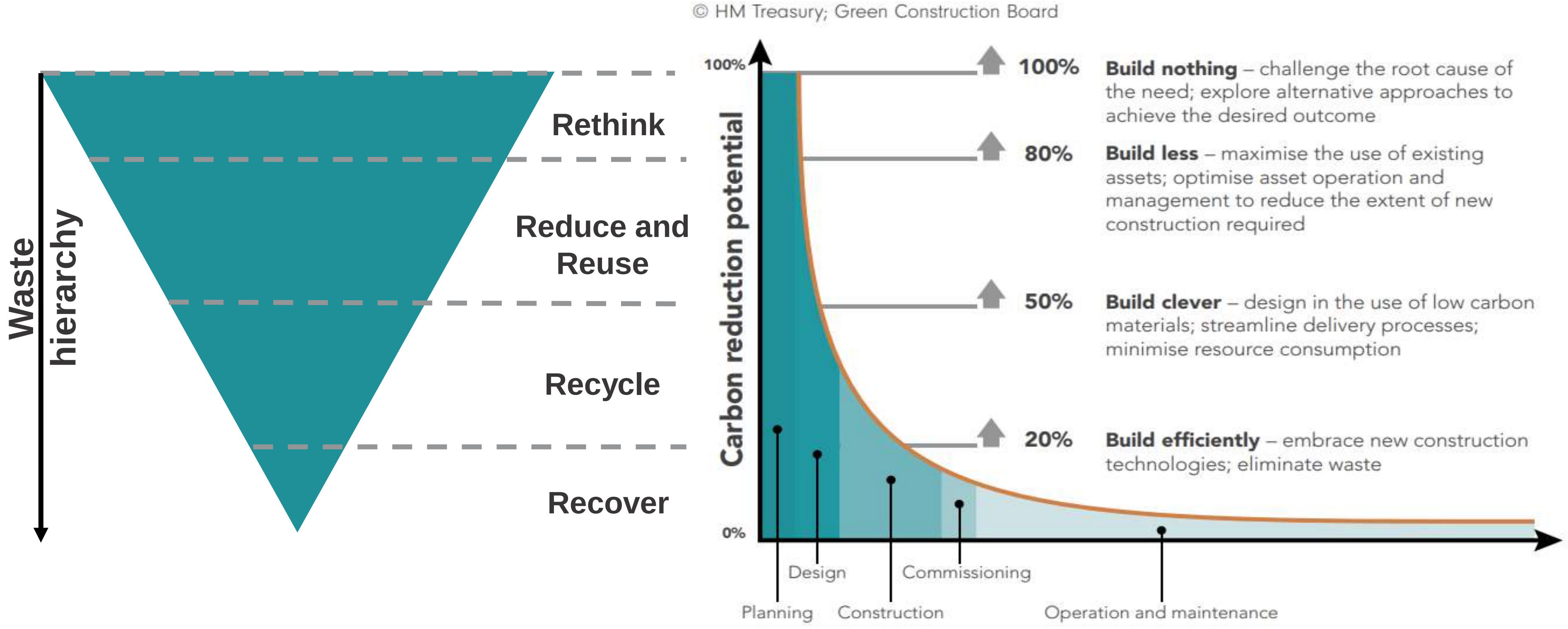
Reducing carbon through material selections is only part of the solution; avoiding (minimising) the use of concrete (and steel) wherever possible is hugely important as is the standardisation of designs – but that requires **significant organisational rethinking** in service delivery models, asset planning and capital works approval process. E.g., Scottish Water has developed modular kiosks which has removed the need for concrete slabs.

4

Water utilities have unique business opportunities to benefit from adopting a **circular economy approach to** its design and procurement processes as illustrated on the next slide. A concrete decarbonisation pathway will be an important part of realising those benefits.

Concrete emissions reduction potential at different stages of asset lifecycle

Using less material as an industry is fundamental to reducing emissions. Shifting design and construction thinking is crucial to achieving this, as illustrated below:



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Overview of Low Carbon Concrete Pathways

Overview of Low Carbon Concrete Pathways

1. Organisation
Set carbon reduction targets

2. Measurement
Monitor concrete emissions in supply chain routinely

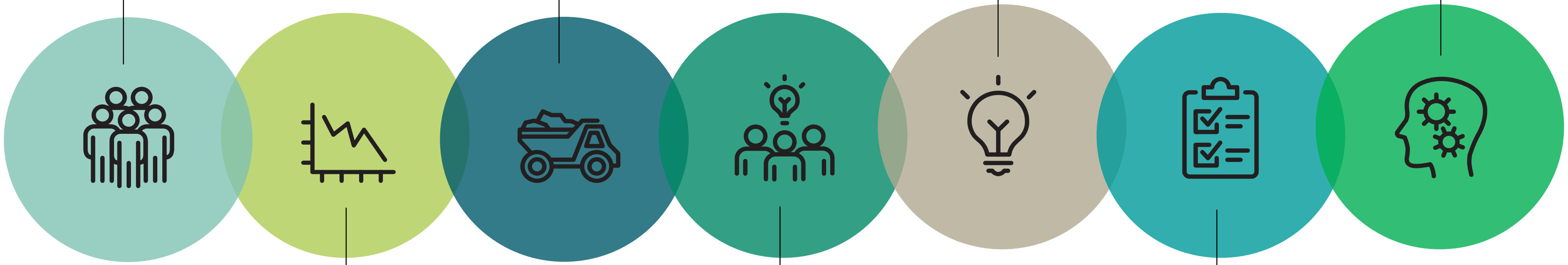
3. Procurement
Adopt green procurement processes

4. Knowledge sharing
Foster collaboration and learning

5. Innovation
Research and development of new products and technologies

6. Technical compliance
Achieve maximum permissible limits stated in standards and specifications

7. Capability
Build technical competence of organisation



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Implementation of Low Carbon Concrete Pathways

1. Organisation

Recommendation

Embed concrete emissions reduction objectives and targets specific to concrete in organisational strategies, plans and processes including design standards and specifications, procurement, risk management, and cost-benefit analysis, in line with global decarbonisation trends.

Purpose

Early adoption of concrete emissions reduction targets to minimise impact of climate change and concrete supply chain risks.

Outcome

Reduce carbon footprint by enabling an organisation-wide approach that is clear, consistent and sustainable.

Implementation tasks

The tasks required to execute this recommendation include:

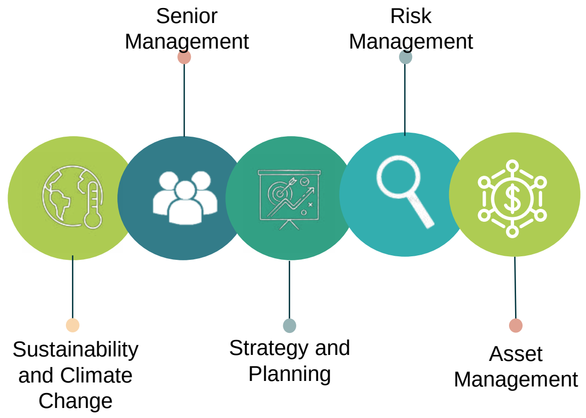
1. **Assess** concrete emissions to identify key sources and hotspots in upstream and downstream supply chain.

2. **Engage** with internal and external stakeholders, including suppliers and contractors, to gather data, assess organisational risk appetite and identify opportunities for carbon reduction, particularly low carbon concrete materials.

3. **Set organisational objectives and SMART target** to reduce concrete emissions (refer to 2. Measurement). E.g., Scottish Water has banned the use of 100% OPC concrete on sites (refer to case study on slide 28); Sydney Water (2022) has set minimum supplementary cementitious materials (SCM) requirements in its technical specifications which are aligned with their broader organisational target to achieve net zero carbon emissions by 2030.

Timing

Responsibility



2. Measurement

Recommendation

Develop a monitoring and reporting procedure to measure concrete emissions and associated costs in supply chain, and if available, integrate into existing monitoring and reporting procedures.

Purpose

Proactively measure and manage performance through data collection and analysis.

Outcome

Timely and accurate data is used to inform decision-making and allow for proactive management of performance, ascertain the costs and benefits of low carbon concrete initiatives and communicate the value to stakeholders.

Implementation tasks

The tasks required to execute this recommendation include:

1. **Identify** concrete emissions categories based on the EN 17472:2022 standard.

2. **Collect data and measure** emissions, using materials with Environment Product Declaration's (EPD) where available, and consider implementing data collection systems to streamline processes and improve efficiencies.

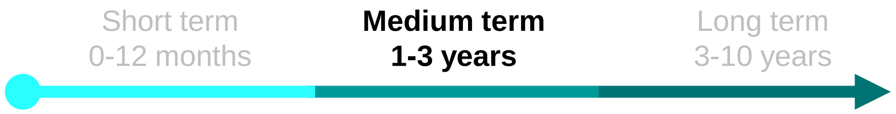
3. **Monitor** emissions data on a regular basis to track performance against targets/KPIs and consider using dashboards to communicate to key stakeholders.

4. **Report and disclose** in line with relevant reporting frameworks and standards as per organisational requirements.

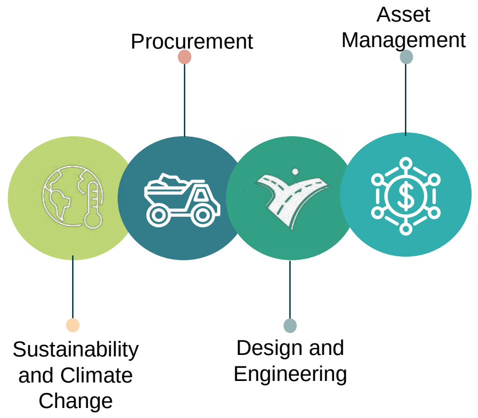
5. **Continuous improvement** by reviewing and refining monitoring processes to enhance accuracy, reliability, and relevance of data to feed into reduction strategies.

6. **Set SMART target** (specific, measurable, achievable, relevant, and time-bound**)** and embed into overall business sustainability goals and commitments (as discussed in 1. Organisation).

Timing



Responsibility



3. Procurement

Recommendation

Set a concrete emissions reduction SMART target (e.g., minimum xx% reduction of ordinary Portland cement (OPC)/GP cement content in concrete elements compared to a base case) in procurement processes including procurement strategies and plans, tender documentation, contracts, business cases and financial strategies and forecasts. Review and adjust the target annually.

Purpose

Promote widespread adoption and acceptance of concrete emissions reduction target and the use of low carbon concrete materials in supply chain.

Outcome

Leverage purchasing power to drive change in concrete supply chain and contribute to global efforts to combat climate change.

Implementation tasks

The tasks required to execute this recommendation include:

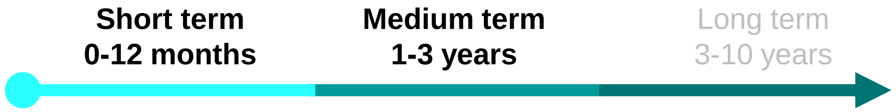
1. **Engage** concrete suppliers to understand capabilities in market, raise awareness and collaborate on product development to minimise emissions throughout the lifecycle.

2. **Define** concrete emission reduction targets and a baseline for procurement activities (refer to 2. Measurement).

3. Integrate carbon reduction targets into **green procurement processes** and supplier selection criteria, favouring suppliers with lower carbon footprints and sustainable practices.

4. The inclusion of performance measures in contracts has proven to be a proactive, targeted approach to increase the use of low carbon concrete materials. Consider including **incentivised performance measures which reward contractors/delivery partners** to encourage behaviour change and innovation.

Timing



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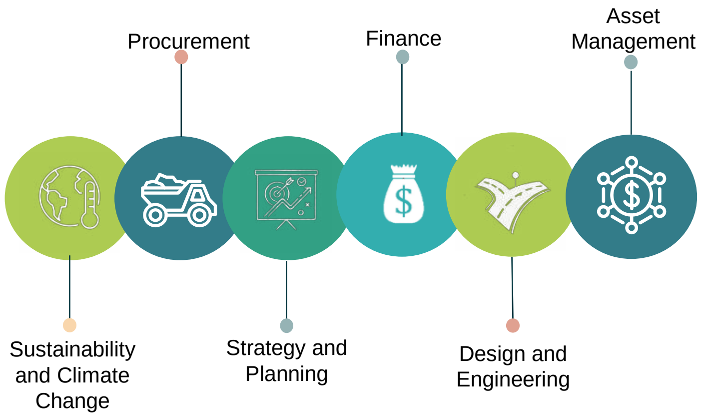


4. Knowledge sharing

Recommendation

Foster collaboration, share best practices, and facilitate learning among internal stakeholders, suppliers, and industry peers to encourage concrete emissions reduction.

Purpose

Accelerate progress towards concrete emissions reduction targets, encourage innovation, and build a culture of sustainability across the organisation and broader supply chain.

Outcome

Collaboration opportunities with industry partners to enhance knowledge sharing and accelerate decarbonisation progress across the water sector.

Implementation tasks

The tasks required to execute this recommendation include:

1. **Establish new or utilise existing platform** for sharing information, resources, and lessons learned related to low carbon concrete materials.

2. **Promote collaboration** cross-functionally and between organisations to address challenges and discuss opportunities.

3. **Identify existing industry forums** to leverage knowledge sharing e.g., Water Services Association of Australia (WSAA), Materials and Embodied Carbon Leaders Alliance (MECLA), ecologiQ, Victorian Infrastructure Delivery Authority (VIDA) Low Carbon Concrete Working Group, SmartCrete CRC.

4. Create **dedicated water utility materials assessment and implementation group** to apply learnings from existing industry forums.

Timing

Short term
0-12 months

Medium term
1-3 years

Long term
3-10 years

Responsibility

5. Innovation

Recommendation

Foster culture of innovation and learning amongst suppliers and academic institutions through reward and recognition and across the water sector more broadly to encourage development of low carbon concrete materials.

Purpose

Unlock new opportunities for low carbon concrete materials, enhance circularity, and create sustainable value for stakeholders across the value chain.

Outcome

Scale up and implementation of successful pilot projects for the use of low carbon concrete in water infrastructure projects across the network.

Implementation tasks

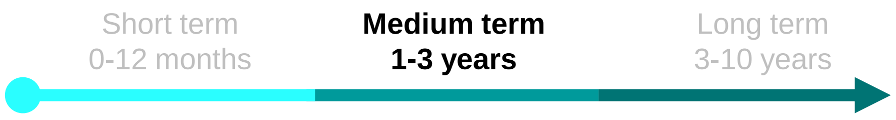
The tasks required to execute this recommendation include:

1. **Engage and collaborate** with suppliers and academia to co-create innovative low carbon concrete solutions (refer to recycled concrete aggregate case study on slide 31 and biochar case study on slide 29).

2. **Implement pilot projects** on low-risk sites and scale up those that are successful (refer to biochar case study on slide 29).

3. **Showcase successful pilot projects** and applications that have utilised low carbon materials effectively, demonstrating their feasibility, performance, and cost-effectiveness.

Timing



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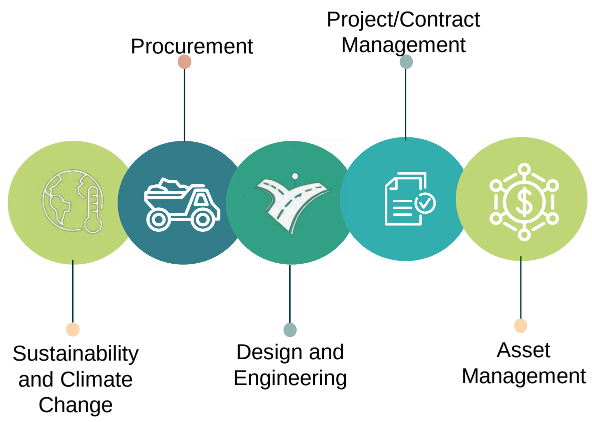


6. Technical compliance

Recommendation

Ensure that engineers and asset managers achieve the maximum permissible limits within design standards and specifications for low carbon concrete materials.

Purpose

Utilise existing allowances within design standards and specifications, or update specifications if required, to drive use of low carbon concrete materials and broader decarbonisation agenda.

Outcome

Use of low carbon concrete materials specified in planning, design, procurement, and asset management documentation.

Implementation tasks

The tasks required to execute this recommendation include:

1. **Review current design standards and specifications*** to understand allowances for use of low carbon concrete materials, and if required, update specifications to meet maximum permissible limits stated in standards.

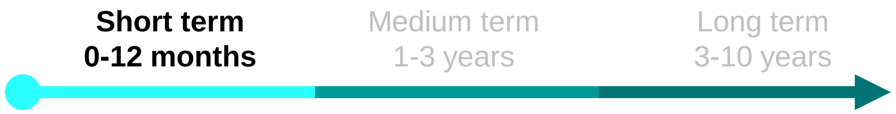
2. **Engage with stakeholders** including design, engineering, contractors, procurement, asset management, and suppliers to ensure they are aware of allowances.

3. **Establish set of minimum requirements** for use on projects and continuously review and update these based on latest advice.

4. Update **Low Carbon Concrete Mix Selection Tool** with the latest information

5. **Specify use of low carbon concrete materials** in design, procurement, and contractual documentation.

Timing



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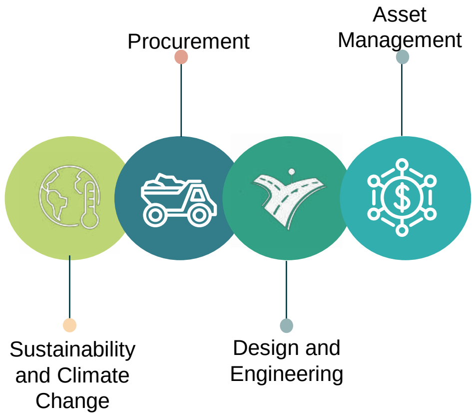


* This task should be undertaken by the cross company technical taskforce (CCTT) – refer to slide 23 for recommendation to set up CCTT.

7. Capability

Recommendation

Invest in building the capability of engineers, procurement team and asset managers to understand the material properties of concrete in contributing to carbon emissions to reduce emissions, supply chain risks and improving circularity.

Purpose

Enhanced capability of organisation to specify low carbon concrete materials in the planning, design, construction and maintenance of assets.

Outcome

Accelerate transition to a more sustainable, circular water sector.

Implementation tasks

The tasks required to execute this recommendation include:

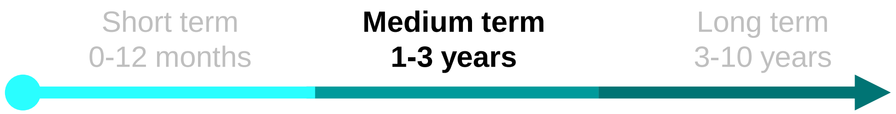
1. Senior Management and Training and Development teams should **evaluate organisational needs and identify gaps/issues** in current project scoping and procurement procedures and develop an adjustment/improvement plan

2. **Allocate resources and implement training** to upskill engineers, procurement, asset managers

3. **Equip engineers, procurement team and asset managers** with the technical knowledge and skills required to evaluate, specify, and design with low carbon materials effectively

4. **Develop tools, guidelines, and decision support systems** to assist in selecting and incorporating low carbon materials into their projects.

Timing



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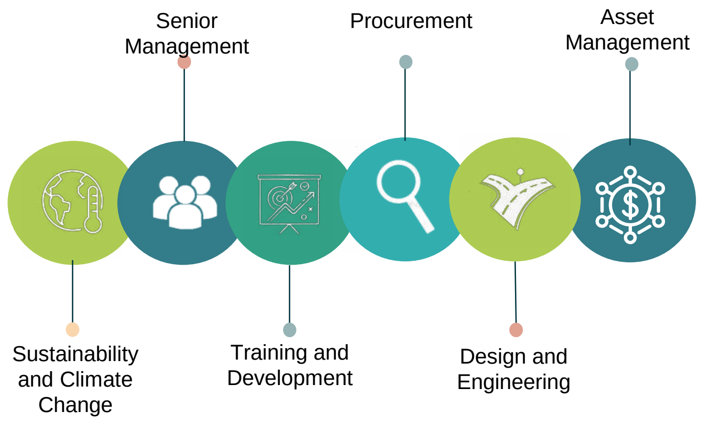

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Next steps

Immediate next steps for all water corporations

1. Reduce the amount of carbon in concrete mixes by using lower carbon concrete mixes currently/readily available from concrete suppliers, by:

a. Implementing the **Low Carbon Concrete Mix Specification Tool (refer to the Tool and LCC Practical Implementation Guide)** within design and procurement teams to improve selection of concrete mixes;

b. Engaging with contractors and their concrete suppliers and subcontractors to articulate carbon reduction targets and discuss main construction constraints so the concrete suppliers can adjust mixes to meet needs;

c. Collating a database of mixes and linking that to the **Low Carbon Concrete Mix Specification Tool** – make it shareable between organisations to help each other make quicker progress in this space. Once operating as required, link it to the MRWA approved materials platform;

d. Set up a **cross company technical taskforce (CCTT)** to proactively drive and manage all facets of the water utilities low carbon concrete program. Membership and composition of CCTT are to be discussed and agreed by water utilities.

2. Run a joint 'design out' concrete awareness program to reduce volume of concrete used against current Business-As-Usual (BAU)

a. Drawing on the lessons learned from Scottish Water's design out program (refer to the case study on slide 29), run a joint design out concrete awareness program to educate designers, engineers, procurement, and contractors/delivery partners on the process (build nothing-build less-build-clever-build efficiently as shown on slide 11), the immediate opportunities and benefits of reducing the volume of concrete used on projects.

b. Depending on the feedback/response from the awareness program, develop a design out training program to equip designers, engineers, procurement, and contractors/delivery partners with the knowledge and tools to inform decision-making processes.

Immediate next steps

3. Create demand in the market for very low carbon concrete materials – e.g. geopolymer concrete, very high SCM concrete (e.g. 75%+ cement replacement) and identify those in research that would benefit from collaborative field trials to speed up their development towards construction ‘readiness’:

a. While this action will fall under the purview of the CCTT, it will require significant input from business planning and commercial teams as it will require adjustment to procurement procedures and tender evaluations to effect a change in the current supply chains.

b. CCTT to collate and share approaches, case studies and learnings from these initiatives to provide maximum benefit to all water utilities from this program and increase the likelihood of success.

c. Run regular sessions with existing and emerging concrete suppliers and recycled waste producers to brief them on water utility needs and to encourage/foster relevant partnerships and collaboration. Start with bi-annual roundtables and involve ecologiQ and the VIDA Low Carbon Concrete Working Group. Polly Gourlay-Philipp is the best contact point for both those groups.

4. Victorian Water Utilities to agree on carbon measurement tool(s) to ensure consistency across the industry and certainty for regulatory submissions.

Consistent carbon measurement will be important to progress to the stage where it is needed to justify increases in fees/charges to allow accelerated reduction in concrete emissions to minimise future offset costs (refer Scottish Water case study on slide 27). Currently, several water corporations including Barwon Water and Melbourne Water have their own carbon measurement tools. It is noted that WSAA might look to develop a standardised carbon measurement tool to be used by all water corporations.

5. Adopt Scottish Water’s decarbonisation cost forecasting tool to the Victorian water utility business context so that utilities can start to predict what impact future carbon off-set costs will have on their financial position.

Refer to Scottish Water case study on slide 27.

6. Develop capability whereby the CCTT for low carbon concrete can also link into circular economy initiatives being driven by the Victorian Water Utilities.

This will be an important mid to long-term step to allow ongoing reductions in the concrete emissions in structural concrete, as the optimisation of SCM use will only get the industry so far. E.g. by combining waste from water and wastewater treatment plants and other waste materials from customers with the clay soils readily available in region can we produce an extremely low (or even zero) carbon structural grade concrete?

Individual recommendations

Yarra Valley Water

- Implement **Low Carbon Concrete Mix Specification Tool** and look to transpose the MECLA/Scottish Water embodied carbon rating systems and project carbon reduction target setting, measuring, tracking and reporting process.

Barwon Water

- Discuss with Barwon Asset Solutions team opportunities to trial low carbon concretes that have recently become available on the market and haven't been evaluated in the field by water utilities for their assets. Start with low-risk elements and look to gain the level of confidence from in-service performance data to allow their adoption for any structural element.

North East Water

- Start exploring the potential for incorporating biochar into concrete mixes with a view to running a detailed laboratory and field trial aligned to the VIDA Low Carbon Concrete Working Group methodology (see attached) but adapted to your concrete specification needs (current one is aligned to DTP's/VicRoads Concrete Specification 610).

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Case Studies

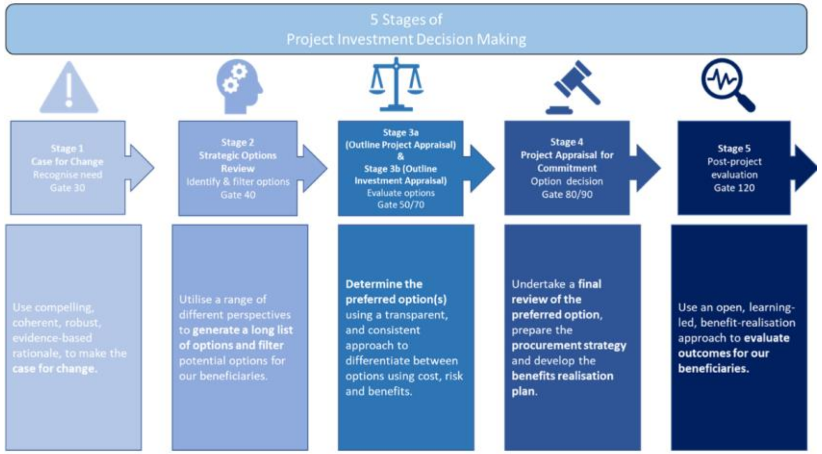
1. Scottish Water – Project Investment Appraisal Framework
2. Scottish Water – Designing out Concrete
3. Biochar: the circular economy opportunity for the water sector
4. Geopolymer trial on retaining walls in transport sector
5. Recycled concrete aggregate proving field trials in transport sector

Scottish Water – Project Investment Appraisal Framework

Scottish Water are aspiring to be a leading organisation, recognised for excellence in how they appraise project investment for the benefit of customers, communities and the environment. Within Scottish Water's **Project Investment Appraisal Framework**, there is a **decarbonisation cost-benefit analysis tool** which compares the upfront cost of investing in reducing the cost of the carbon during the capital project versus the future cost to the business of purchasing carbon offsets. This allows them to ___plan, manage and prioritise challenges and ensure customers' money is invested in a way that maximises long-term value.

Project Investment Appraisal is the process of assessing the costs (including carbon), benefits (social, economic and environmental) and risks of alternative ways to meet objectives, whether that be Scottish Water objectives or wider objectives. The tools allows for several factors to be considered, including:

- Initial investment costs
- Long-term savings
- Market and financial risks and benefits (government incentives and subsidies)
- Energy price volatility
- Fluctuations in offset costs
- Regulatory risks
- Environmental impacts
- Customer expectations



The tool has been used to justify to the regulator customer price increases being passed on to customers now as the cost of construction does increase when low carbon materials are used, but with the pay-off that future fees and charges will not escalate at a greater rate because of future offset costs to achieve net zero emissions by 2040 being factored into the analysis.

This approach to cost-benefit analyses should be considered by Victorian water corporations so that they can start to predict what impact future carbon offset costs will have on their current financial position. This does require the establishing a baseline of carbon created by the business at both the build phase and the throughout operations so that the relevant financial metrics can be deployed in the Value Review tool with confidence by the Executive.

Scottish Water – Designing out concrete

- Scottish Water has set a **net zero target to 2040** and produced a Net Zero Emissions Routemap to outline the pathway to achieving this target (refer to Figure 1).
- The Routemap found that civil engineering investments in 2019/20 accounted for 60% of carbon emissions. Concrete accounts for 18% + rebar = 25% of total emissions.
- Opportunity of up to 10-12% reduction of concrete emissions through alternative concrete adoption.

Key actions include:

- **Designing out concrete using optioneering tool.** Designers need to rationalise use of concrete e.g., reducing kiosk slab thickness will reduce 33% of concrete required. Modularisation of kiosk design means that the metal frame now sits on compacted Type 1 fill instead of concrete slab (refer to Figure 2).
- Historically, projects were delivered using CEM I (100% OPC) concrete because this was the cheapest option. Scottish Water has now **banned the use of CEM I concrete on its sites** identifying it as a 'non-conformance' if a contractor inadvertently uses it.
- Developed a **low carbon concrete matrix** to select concrete mixes.
- Revised **concrete supply framework** to only price CEM II and CEM III (concretes which replace cement with GGBS and PFA).
- **Commenced trials on low carbon blended mixes** (EcoPact/Ventura), Carbon Cure; looking to trial Calcined Clays, Cemcor, Hoffman Green etc.

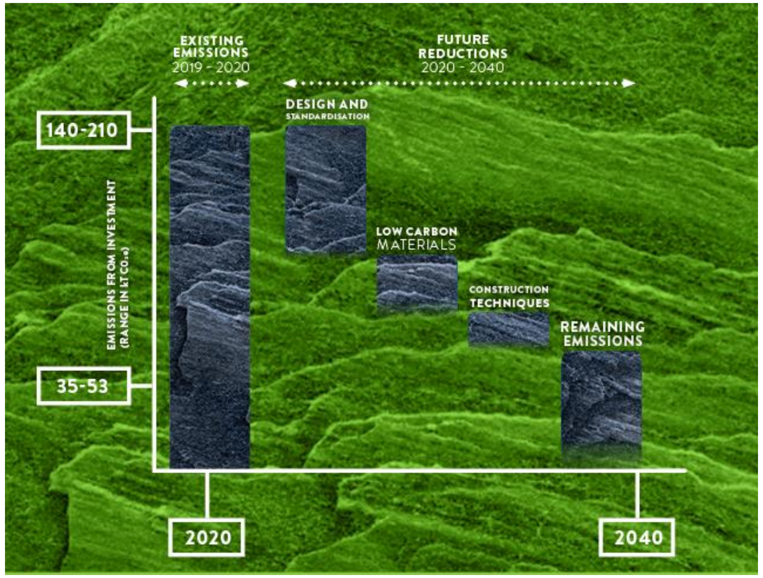


Figure 1: Pathway to net zero

Kiosk Slabs	Vol Conc (m3)	Reduction
Traditional (3x3) 300 deep	2.7	baseline
Traditional (3x3) 200mm deep	1.8	33%
Strip footing (2nr [3x0.3x0.3])	0.54	80%
Pad footings (4nr [0.3x0.3x0.3])	0.108	96%
Compacted Type 1	**0.0**	**100%**

Figure 2: Design optioneering to reduce concrete

Biochar: the circular economy opportunity for the water sector

Biochar is the product of biomass (food and garden waste or biosolids) turned into a carbon rich charcoal type substance by the process of pyrolysis (oxygen free incineration). It is traditionally used to improve soil quality, but its other uses include cement replacement in concrete.

The challenges of using biomass (quality and quantity of product, limited market value) are outweighed by the opportunities, namely:

- Improved sustainability outcomes through circular economy principles to assist decarbonisation journey
- Possible enhanced revenue diversification opportunity if biochar utilisation is feasible
- Possible insulation from lack of market supply of recycled / low carbon content for construction materials

North East Water are kicking off biochar trials in 2024.

- **Phase 1** trials consist of testing a range of feedstocks (biosolids, FOGO and wood products) through a biochar pilot plant in Melbourne.
- The trial will identify the quality and quantity of feedstocks and Chemicals of Emerging Concern (CEC) removal %.
- Phase 1 will build the business case to progress to **Phase 2**, which will include a processing unit on a NEW site running larger volumes of the desired mix.
- **Phase 3** will build the business case for a larger, 20,000 to 60,000 tonne per year biochar plant.
- The business case includes signing contracts with organisations that would supply different wastes outside of water corporations.
- NEW plans to use the products produced from Phase 1 and 2 for cement trials. Opportunities exist with locally located concrete suppliers for mutually beneficial circular economy outcomes.

Yarra Valley Water have been exploring biochar in concrete together with RMIT. Sourcing adequate amounts of biochar of the right quality has been a limiting factor. Testing at lab scale is achievable but getting enough for field trials and applications at large is more challenging.

Barwon Water have been researching the production and application of biochar in batteries (Biochar 2 Batteries) with RMIT, Deakin University and others. Their Regional RON is expected to produce 5000 tonnes of biochar per year from November 2026.

Geopolymer trial on retaining walls in transport sector

ecologiQ performed site inspections (visual, sampling, on-site testing and laboratory testing) in 2023 on two retaining walls that were built in Melbourne in 2013 using **geopolymer concrete manufactured from blast furnace slag (100% Portland cement replacement with approx. 90% GGBS and 10% fly ash)**.

The main objective of the investigation was to assess the long-term performance of the geopolymer exposed to field conditions. The retaining walls are located at M80 WRR (inbound), Sunshine North and Dudley St. Bridge, West Melbourne.

The results of the investigation were as follows:

- The **visual inspection of both retaining walls revealed no major defects or deterioration**. Some cracking was identified, and this has been assessed to be related to shrinkage cracking in the early ages of the structure's life. The maximum crack width measured during the inspection of the panels was 0.35 mm and the overall cracking was typically ranging between 0.15 and 0.35 mm.
- The mixes used on both walls were designed to meet the requirements of VR400/40 as per VR610. The **compressive strength results confirmed that the mixes are above 40 MPa**, providing good evidence that the geopolymer was durable and did not lose strength over time.
- Some superficial fretting was observed in both retaining walls near the edge of the panel interface. Testing hasn’t been able to conclusively identify the cause of this fretting. It is understood that some early age efflorescence might have occurred in the panels and may have contributed to this fretting. No efflorescence was present during this survey. The observed fretting was localised in nature and superficial in depth and largely had a local aesthetic impact.
- Except from the superficial fretting, **no durability issue was identified** on the tested structures which would impact on the ability of the structure to achieve its design life for the proposed function, providing **evidence of the long-term performance of slag based geopolymer mixes** under field conditions.

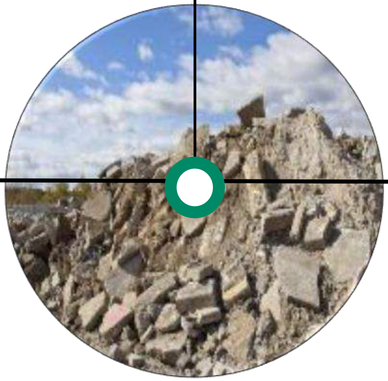
Example of a proving field trial undertaken on a project - Recycled concrete aggregate

July 2022

Initial discussion with project:
1. Developed recycled concrete aggregate (RCA) initiative assessment and approval process
2. Deflection wall application

July – Aug 2022

Industry engagement:
1. Engaged Boral, Hanson and Holcim to develop trial mixes
2. Developed initial testing plan



Aug 2022

Initiative proposal:
1. Design team review
2. MTM review
3. Academic peer review
4. DTP review

Sep 2022

Proposal acceptance
Technical review group

Sep - March 2022 - 2023

Trials and visits
1. RCA supply visits
2. Lab trials visits
3. Technical review group workshops

March 2023

Protection slab pour
Supply chain upgrade

Hanson RCA mix submitted for DTP certification

TBC 2023 - 2024

Identify project application

Conditional approval (2024)
Future Specification update (2024 onwards)

Key requirements to succeed:
- Clear path to what the end goal is and how to get there.
- Ensure adequate staffing and resources to make a change happen. Many engineers, supervisors and suppliers operate on a least path of resistance.
- Make calculated, measured approaches to implementing something. Small incremental changes from a base approved mixed will help get closer to a complaint
- Most importantly, collaboration from all parties is required: Design, Procurement, Delivery.

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Resources and References

Resources

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6. Institution of Structural Engineers UK Concrete technology tracker
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Thank you.

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