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Abstract Book

Decarbonised Concrete – What's stopping us? An Australian perspective

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Session 1, Kawau, October 16, 2025, 9:00 AM - 10:35 AM

The decarbonisation of concrete is one of the most urgent and complex challenges in the global race to net zero. Cement and concrete are fundamental to modern infrastructure, yet they are also responsible for a significant share of industrial emissions. While innovative technologies and low-carbon products are emerging, widespread adoption requires more than just technical breakthroughs — it depends on the strength of the market environment in which they are introduced.

This presentation will explore the key market enablers that can accelerate the transition to sustainable concrete. Drawing on insights from industry collaboration and applied research, the presentation will outline how demand signals, investment frameworks, regulatory settings, skills development, and industry standards can collectively unlock systemic change. By addressing these enablers, we can create the conditions for sustainable concrete solutions to move from pilot projects into mainstream practice at scale.

The presentation will make the case that achieving meaningful emissions reductions in concrete requires a systems-based approach: one that connects research, policy, investment, and practice. By focusing on market enablers, we can align incentives across the value chain, reduce risks for innovators, and provide confidence to both suppliers and end-users.

Structural Design of Bledisloe North Wharf

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Session 2A, Kawau, October 16, 2025, 11:10 AM - 12:30 PM

This paper describes the structural design of a new 320m long, 27.5m wide, open pile, suspended deck wharf at Port of Auckland. The project aimed to provide a lean and efficient design that minimised construction materials, while balancing programme and design cost. The paper discusses the steps taken during design to provide an efficient structure, building on experience of previous designs for similar structures in the same port.

Economising the design included reducing the pile casing sizes used on previous projects in the same location. Pile sizes and reinforcing contents were able to be optimised by consideration of structural ductility, non-linear soil-structure interaction and displacement-based design techniques for seismic design. Seismic resilience and post-seismic recovery were considered through the use of performance-based design criteria, aimed at controlling damage levels at lower levels of earthquake to enable repair and recovery.

A precast concrete superstructure construction was chosen in favour of in situ slab construction, with the intention of increasing durability by allowing the construction to have greater control over the quality of the concrete precasting process in comparison to in situ construction. Follow on effects include a potential increase in the speed and ease of construction.

Minimising embodied carbon and whole of life carbon emissions in the design was achieved by efficiency in use of materials, minimising maintenance by detailing for a 100-year design life, and reduction of cement content in mix designs by use of supplementary cementitious materials. Design of the wharf accounts for the projected Relative Sea Level Rise (RSLR) over the design life of the structure, considering the projected Sea Level Rise (SLR) due to climate change and Vertical Land Movement (VLM) due to gradual land uplift or subsidence.

Seeing Further - Hihiani Radar Project, Hawkins Hill, Wellington

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Session 2A, Kawau, October 16, 2025, 11:10 AM - 12:30 PM

In 2020, Airways New Zealand embarked on upgrading their network of aircraft surveillance radar across New Zealand with three new radars located in Christchurch, Wellington and Auckland.

The Wellington radar is located at Hawkins Hill, to the southeast of the city on a hilltop projecting into Cook Strait.

The existing facility was constructed in the early 1990's overtop of a buried reinforced concrete bunker type installation constructed in the 1980's. Within the compound, the original radar was located on a 3.3m diameter, 5m high circular concrete tower within a protective external reinforced concrete cylinder of 12.5 metres diameter. A seismic assessment of the original installation was undertaken in 2014 identifying some issues for compliance with current design standards. The installation must meet Importance Level 4 (IL4) requirements, as it forms critical national infrastructure, and is very exposed to the prevailing winds and high Wellington seismic loads.

To install the new radar, ensure the facility can withstand the site wind forces and meet the IL4 requirements, structural strengthening and retrofitting was required to the existing facility. A site specific seismic hazard analysis was undertaken to consider the new National Seismic Hazard Model (NSHM) as described in TS 1170.5 and additional consideration of wind loading for the revised 2021 AS/NZS1170.2 was undertaken.

Performance parameters for the radar's continuing operation after an event were critical for development of the final strengthening design. The final solution incorporates 250 thick reinforced concrete internal wall around the inside of the 12.5m diameter circular turret, with a new 200 thick composite concrete diaphragm slab over and foundation strengthening.

Construction began in 2023 with strict timelines and was completed on time for the radar equipment to be installed. The facility is now undergoing testing before being put into operation to provide radar coverage over central New Zealand.

Bentonite support fluid – interactions with steel reinforcing bar and the effect on concrete-rebar bonding

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Session 2A, Kawau, October 16, 2025, 11:10 AM - 12:30 PM

During the early stages of a Contact Energy project in 2021, Beca reported bentonite deposits forming on galvanised items attached to a non-galvanised reinforcing cage that had been immersed in a bentonite support fluid on a previous roading project. They reproduced the effect in benchtop tests at Contact Energy's site office, leading Contact Energy to use non-galvanised reinforcement instead of the galvanised bar originally specified for some deep concrete placements.

In 2023, Contact Energy commissioned WSP to carry out laboratory tests using a commercial bentonite support fluid formulation to better understand the observed interactions and their potential consequences.

WSP's testing showed an inherent tendency for bentonite to deposit from the support fluid onto galvanised rebar, particularly when the galvanised bar was electrically connected to non-galvanised bar or when connected to an electrical source that gave it a positive charge. In contrast, less bentonite deposited on non-galvanised bar and none deposited on non-galvanised bar electrically connected to galvanised bar. The deposition was attributed to the negatively charged bentonite particles being attracted to positively charged zinc or steel surfaces on electrically isolated bars, and to the positively charged anodic bar when bars were electrically connected or connected to an electricity source. The bentonite deposits thickened progressively with increasing immersion time.

The bentonite deposits were not completely displaced by flowing concrete placed under a support fluid as in a tremie placement even after an immersion period as short as 24 hours. The thicker the deposit the more was retained on the bar when the concrete was placed. Where present, the residues prevented the concrete bonding to the rebar.

The paper describes the testing carried out and the findings, discusses the likely effects on concrete-rebar bond strength, and suggests options for managing the risk of reduced bond in concrete placed under bentonite support fluid.

Robot-Ready Floors: Aligning Concrete Floor Performance with Warehouse Automation

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Session 2A, Kawau, October 16, 2025, 11:10 AM - 12:30 PM

The rapid adoption of goods-to-person (G2P) automation, autonomous mobile robots (AMRs), cube-storage grids (e.g., AutoStore™), shuttle-based AS/RS, and very-narrow-aisle automated guided vehicles (AGVs) is redefining the performance requirements for concrete floors. Historically, a warehouse floor could be designed and constructed for generic needs—static racking loads and "Free Movement" surface regularity—and still be fit-for-purpose for a broad range of logistics tenants. In the age of robotic automation this is no longer true: the floor design and construction process must be integrated and optimised for tenant-specific automation requirements. These requirements are often bespoke to robotics vendors and must be balanced against asset-owner goals and site constraints.

This paper classifies the key automation system families and highlights the floor attributes most critical to each, including:

- flatness and levelness
- joint stability and continuity
- surface durability and abrasion resistance
- differential settlement control
- additional properties such as crack width, reflectivity, friction and ESD behaviour.

Drawing on local and global case studies, we demonstrate how these requirements translate into practical design, specification, and construction delivery. We then present a roadmap that equips developers, engineers and contractors with strategies to deliver floors that are demonstrably "robot-ready" while balancing capital expenditure, programme, and sustainability. Finally, we comment on novel slab-repair and maintenance issues that have arisen where floors were not properly adapted to the demands of robotic automation.

Concrete materials technology: selected ABCs to improve project decisions and outcomes

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Session 2B, Rangitoto, October 16, 2025, 11:10 AM - 12:30 PM

Queries the authors have received about concrete materials in recent years - whether about testing, specification, assessing a proposed construction solution, or investigating an apparent shortcoming - have revealed recurring themes in New Zealand projects and shown the difficulties of keeping up with an ever-widening range of materials, products, and practices as well as ever-increasing expectations.

Finding the right answer to each query has highlighted that the party tasked with an apparently straightforward decision might not be aware of (or able to control) other aspects of materials, construction, or in-service conditions that will influence the outcome of their decision.

This paper focusses on three topics: air entrainment, cementitious binders, and curing. It addresses common misunderstandings and knowledge gaps identified when answering queries from projects, giving a concise overview of the key points and their practical significance in New Zealand in 2025.

It also explains how these topics relate to wider aspects of constructability and subsequent service conditions on a project, demonstrates how selected aspects might be considered as part of the wider system to ensure an acceptable outcome, and refers readers to readily accessible industry resources for further information.

By raising awareness of these issues, the paper will enable designers, specifiers, project managers, product suppliers, contractors, asset owners, and others in the supply chain who rely on the expertise of other parties to ‘join the concrete dots’, to ask the right questions to get the answers they need so their decisions are well-informed and deliver good outcomes for all parties.

Energy requirements and cost analysis for drying pumice for use as a supplementary cementitious material

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Session 2B, Rangitoto, October 16, 2025, 11:10 AM - 12:30 PM

The concrete industry is facing escalating pressure to reduce CO_2 emissions. With around 8% of the global CO_2 emissions resulted from cement production alone, reducing cement demand through incorporating supplementary cementitious materials (SCMs) has been promoted as a promising strategy. Pumice, a naturally porous volcanic material abundantly available in New Zealand, has gained attention as a sustainable SCM in concrete production. However, drying and grinding pumice to produce pumicite are critical pre-treatment processes required to enhance its pozzolanic reactivity and ensure compliance with its moisture content and optimum fineness levels. This research presents a theoretical analysis based on thermodynamic principles to estimate the energy required for drying one tonne of pumice from an initial moisture content of 30% to a target of 2%, using steady-state assumptions and thermophysical property values. The energy demand was calculated based on the sensible heating of both water and pumice from 17°C to 100°C and the latent heat required for the vaporisation of water. The specific heat capacities of water and pumice were taken to be 4.18 kJ/kg·°C and 0.87 kJ/kg·°C, respectively, while the latent heat of vaporisation was taken as 2,256 kJ/kg. Results indicate that drying one tonne of pumice requires at least 789,956 kJ/tonne (around 219 kWh/tonne), with water evaporation accounting for over 80% of the total energy. A cost analysis using New Zealand's average LPG and Natural Gas prices and an efficiency factor of 90% yields a drying energy cost of approximately $32.91 and 17.07 per tonne respectively. These results provide a theoretical reference for evaluating the environmental and economic feasibility of large-scale pumice processing. The findings support ongoing efforts to integrate pumice into low-carbon concrete production and inform material selection strategies to minimise energy in concrete production.

Keywords: pumice, pumicite, drying energy, concrete, energy consumption, New Zealand

Experimental study on predictive models for anchorage in concrete incorporating Supplementary Cementitious Materials

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Session 2B, Rangitoto, October 16, 2025, 11:10 AM - 12:30 PM

To determine the capacity of anchors in concrete, most relevant international and national standards adopt the Concrete Capacity Design (CCD) method, a simplified and user-friendly model for which the basic concrete tensile capacity of an anchor can be predicted measuring the concrete compressive strength and the anchor's effective depth.

Extensive research has demonstrated that, for normal concrete and commonly adopted geometric proportions (foot size and effective depth), the CCD method provides reliable and conservative results. However, is it still the case in a concrete mix with Supplementary Cementitious Materials (SCM) and when the geometric proportions change? Are there alternative models in literature, that can be considered to proficiently predict the concrete cone capacity?

To answer those questions, the authors have tested 130 anchors cast in SCM concrete mixes, with variations of the effective depth and of the foot size. The results are presented in this paper, together with a non-linear regression analysis to adjust the key parameters of the models and find the best fit for the set of results.

Estimation of the CO2 emissions of limestone calcined clay- based 3D- Concrete Printing mixtures

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Session 2B, Rangitoto, October 16, 2025, 11:10 AM - 12:30 PM

3D concrete printing (3DCP) is a rapidly growing technology in the construction industry. The number of projects completed with this technology is growing exponentially. Although 3DCP provides several benefits such as construction time saving, improved construction accuracy, and geometrical freedom, questions remain about its environmental impact. Due to the challenges related to pumping and surface finish, the majority of 3DCP companies utilize mortar rather than ordinary concrete with coarse aggregate, leading to higher cement demand and associated increased CO2 emissions. As part of a large MBIE-funded project, the 3DCP team of the University of Canterbury has introduced local materials (e.g. limestone, calcined clay and zeolite) as partial cement replacements in 3DCP mortars. 3DCP mixes have been developed that meet the rheological properties required for printing while being suitable for structural purposes in terms of strength and durability.

This study aims to evaluate the life cycle analysis (LCA) of the abovementioned 3DCP mixes and determine the environmental advantages of locally sourced materials in New Zealand's 3DCP construction sector. The impact assessment model selected for this study was a midpoint-oriented Life Cycle Impact Assessment (LCIA). The environmental impacts were estimated for the Product stage (A1-A3). Preliminary results indicated that the 3DCP mixes developed, which contained limestone, calcined clay and zeolite up to 45% cement replacement, have the potential to reduce CO2 emissions up to 40% when compared to conventional Portland cement 3DCP mixes. This study highlights the importance of adopting local materials in 3DCP to fully exploit the benefits of this novel technology also at the environmental level.

Te Whau Pathway Project: Modular Precast Design for Low-Impact Construction in an Ecologically Sensitive Marine Environment

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Session 3A, Kawau, October 16, 2025, 1:00 PM - 2:50 PM

The Te Whau Pathway Project brings to life a vision of Auckland Council to construct a 15km shared-use path along the Whau River. This portage honours a traditional route taken by mana whenua and will enable connection of communities along the alignment from the Waitematā to Manukau Harbour.

The project is divided into five sections, with part of section 5 currently under construction. This includes 1.1km of ‘boardwalk’ structure traversing an ecologically sensitive mangrove environment. The design was developed under an Early Contractor Involvement (ECI) model, with Beca as the Designer and HEB Construction as the Contractor.

Close collaboration between the Designer and Contractor during the ECI phase was crucial in developing a solution that would meet the project constraints and is able to be repeated on subsequent sections of the alignment as funding becomes available. The solution extensively utilises precast concrete components to achieve key objectives such as durability, low maintenance, and aesthetic appeal, demonstrating the material's versatility.

Given the ecological sensitivity of the site, the design and construction methodology was developed with a focus on minimising environmental impact. To satisfy this constraint a 'build-over-the-top' method was proposed, to allow construction to proceed from on top of the ‘boardwalk’ structure. This approach is facilitated by a modular design, with all components prefabricated off-site, enabling efficient and low-impact on-site assembly.

With the design complete and the construction well underway, the first part of the presentation will focus on the structural design — particularly how the modular components are assembled through carefully considered structural detailing to ensure the desired ongoing structural performance in an aggressive marine environment and reduce construction cycle time. It will also cover construction techniques, including the build-over-the-top methodology and the use of digital tools to detail and track precast elements, minimising construction errors.

Takitimu North Link – Stage 1

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Session 3A, Kawau, October 16, 2025, 1:00 PM - 2:50 PM

The Takitimu North Link Stage 1 project will provide a new expressway connecting Takitimu Drive (SH29) through to State Highway 2, including upgrades to the connecting stretch of State Highway 29. Takitimu North Link Stage 1 will include 6.8km of new expressway. The Takitimu North Link Project is part of the New Zealand Upgrade Programme (NZUP).
Takitimu North Link Stage 1 is being delivered by Fulton Hogan Limited and HEB Construction Limited as a Joint Venture (Constructor) under a Design and Construct contract. The design of the project is being delivered by Beca Ltd (Beca), as lead designer, with Holmes NZ Limited Partnership (Holmes) as a subconsultant.
The project comprised of technical challenges and innovations including.

- Holmes and HEB developed a new concrete prestressed beam form which was verified by Beca.
- The design modified the NZTA proposed displacement based methodology and developed a method to incorporate abutment piles hinging, including accounting for higher mode effects
- Construction of top down structures in locations of deep final excavated shapes and innovative methods for preventing slender combined column /piles from buckling
- Anchorage of stirrups
- Accelerated curing of bridge beams and durability questions

The paper concludes with lessons learned from the design and construction of these significant structures and discusses some construction details developed to optimise constructability.

The Electrification of Local Steelmaking and Reinforcing Bar Manufacturing

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Session 3A, Kawau, October 16, 2025, 1:00 PM - 2:50 PM

The installation of an electric arc furnace (EAF) at NZ Steel Glenbrook site, south of Auckland will reduce the scope 1 emissions of locally made steel by over 45%. Reinforcing steel also made in Otahuhu, South Auckland, will use steel from this EAF will and make some reinforcement from 100% scrap steel. These new 100% scrap based reinforcing, made utilising NZ's highly renewable grid, will be certified with an exceptionally low embodied carbon EPD, even by global standards. This will give engineers and designers even more options to meet the carbon goals of projects, enabling emissions associated with rebar by over 85%.

Experimental Investigation of Composite Anchoring Systems for Load Transfer Between Carbon fibre Connectors and Concrete Under Flexural and Axial Tension Loading Conditions

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Session 3A, Kawau, October 16, 2025, 1:00 PM - 2:50 PM

This paper presents an experimental investigation into the performance of composite anchoring systems designed to ensure effective load transfer between carbon fiber connectors and concrete under combined loading scenarios. The study focuses on two primary mechanisms: flexural tension, evaluated through three-point bending tests, and axial tension, assessed via monotonic tensile loading. Prismatic specimens with reduced cross-sections were used to induce controlled cracking under flexural loading, while concrete blocks were subjected to direct tension in accordance with the NF EN 18-422 standard. Carbon connectors were embedded in inclined boreholes to simulate realistic stress transfer paths.

Results from the bending tests demonstrated localized failure in the targeted tensile zone, confirming effective stress transmission via the anchor. In pure tension, consistent failure loads and modes validated the repeatability and reliability of the anchoring system, with less than 10% standard deviation across specimens. Additional testing on reinforced concrete beams equipped with FRP strips and composite anchorage at 60° and 90° configurations showed an average increase of 39% in load-bearing capacity compared to unanchored counterparts.

These findings are supported by analytical formulations that offer predictive insight into anchorage performance, making this study relevant for advanced structural strengthening applications involving carbon-FRP systems.

Review of the pozzolanic reactivity testing methods for Supplementary Cementitious Materials (SCMs)

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Session 3B, Rangitoto, October 16, 2025, 1:00 PM - 2:50 PM

Pozzolanic materials are the primary resources used as Supplementary Cementitious Materials (SCMs) to make more sustainable concrete. Pozzolans can contribute to the strength of cement through pozzolanic reactions, consuming portlandite from the cement hydration and creating secondary C-S-H gel. Reactivity of pozzolans is also defined as their ability to consume more portlandite, resulting in enhanced cementitious properties. Since pozzolans can exhibit varying reactivity performance, numerous reactivity testing methods have been proposed following extensive research to identify potentially reactive pozzolans for the cement and concrete industry. In this paper, different reactivity tests such as Chapelle, Frattini, lime reactivity test, Strength Activity Index (SAI), Bulk Resistivity Index (BRI), R3 (heat release and bound water), modified R3 and the recently developed UR2 are reviewed and compared based on their potential to identify pozzolanic and inert materials, the cost of equipment needed, and the time required for conducting the test. This paper can serve as a guide to select an appropriate testing method for categorizing pozzolans from a reactivity perspective.

Rapid-Hardening Concrete in Airside Infrastructure: A Case Study of Large-Scale Application at Melbourne Airport

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Session 3B, Rangitoto, October 16, 2025, 1:00 PM - 2:50 PM

Third-Generation rapid-hardening concrete is redefining how infrastructure projects are delivered across a range of high-demand environments, including road networks, rail corridors, and airside operations. Its capacity for accelerated strength gain, flexible placement windows, and long-term durability makes it an ideal solution for projects requiring minimal downtime and uninterrupted functionality. Additionally, it contributes to reduced environmental impact, aligning with global sustainability goals.

The Melbourne Airport Pavement Maintenance Program 2.0 (MAPMP 2.0) demonstrates this capability in one of the most operationally complex environments: a major international airport. Engineered IQ, in partnership with local companies, replaced 144 rigid pavement slabs—each 7.6m x 7.6m x 580mm—within a nightly work window of just 6 to 7 hours.

Concretum® Q-FLASH 2/20, a Third-Generation rapid-hardening concrete, achieved 20 MPa compressive strength in under two hours and >3.0 MPa flexural strength within four hours. Its ability to adapt to different ambient temperatures (5°C - >30°C) while maintaining the project-specific open time ensured consistent placement across diverse conditions. Using Third-Generation rapid-hardening concrete, the open time can be adjusted between 30 and 120 minutes, according to the requirements of the project. Volumetric mixers on-site enabled precise quality control and continuous supply during operations.

Pre-construction trials helped optimise the mix design in terms of slump consistency and workability, ensuring uniform finishing using both manual and mechanical screeding techniques. The risk of shrinkage cracking was significantly reduced through the use of Third-Generation rapid-hardening concrete.

The rapid return to service allowed all slabs to be handed back to airport operations before the first morning flights, avoiding any need to tow aircraft, divert gate allocations, or bus passengers between terminals and remote stands. The procedure not only minimised operational disruptions but also reduced fuel consumption and emissions associated with aircraft detours and passenger transportation, contributing to the overall sustainability of the project.

Ultra-High Performance Concrete (UHPC) - an environmentally friendly concrete solution

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Session 3B, Rangitoto, October 16, 2025, 1:00 PM - 2:50 PM

In recent years much research has been undertaken to investigate the potential to produce high strength concretes for structural applications. These have demonstrated the feasibility of producing very high strength cement-based materials. These have shown benefits in terms of reduced material quantities and improved sustainability and durability.

While the focus has been utilising the substantial strength performance in high demand applications little work has been done to evaluate the potential for its use in more conventional situations. The University of Waikato is undertaking research to evaluate UHPC as an alternative to normal concrete in conventional reinforced concrete elements. The absence of coarse aggregates in the mixes enables much thinner beam sections to be produced with UHPC. Performance of 100 mm square section beams using a conventional 30MPa concrete mix was compared with 'I' section beams made with UHPC; in both cases reinforcement was provided by two 6 mm 500 Grade steel bars. Four point bending tests showed the beams had comparable flexural capacity.

An evaluation of the two designs showed that cost per cubic metre of the UHPC was nearly twice as much as the normal concrete. However, the UHPC beam used only half of the concrete volume resulting in a similar price per element. In addition, analysis of the global warming potential (GWP) showed that UHPC has a higher GWP per metre but was less than the conventional concrete in the beam element. The reduced unit weight will also give logistical and construction process benefits although these haven't been quantified.

AI-DRIVEN OPTIMIZATION IN CONCRETE LOGISTICS: A PATHWAY TO NET-ZERO AND OPERATIONAL EXCELLENCE

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Session 3B, Rangitoto, October 16, 2025, 1:00 PM - 2:50 PM

Concrete logistics plays a pivotal role in building materials producers' pursuit of net-zero carbon emissions. This paper explores how Artificial Intelligence (AI), particularly mathematical optimization techniques, can substantially improve operational efficiency in concrete distribution. By integrating AI-supported dispatching, telematics, predictive analytics, and real-time optimization into logistics operations, building material producers can significantly reduce costs and lower carbon emissions at the same time.

It should be well known meanwhile that AI-driven optimization algorithms can enhance truck productivity, minimize empty mileage, and reduce the number of vehicles required to meet delivery schedules. For instance, implementations have led to a 37% increase in loads per truck per day and up to a 30% reduction in fleet size. Additionally, AI-powered route optimization has been shown to reduce carbon emissions by approximately 20%. Moreover, by rethinking traditional payment schemes and adopting cost-based models, building material producers can ensure that financial gains from optimization are fully realized, creating a win-win for suppliers and haulers alike. This paper argues that these benefits can only be realized if companies stop treating these initiatives as a simple IT upgrade, but more as a transformative strategy requiring significant organizational change. AI-driven network optimization further enables strategic decisions such as plant repositioning and supply network adjustments, driving long-term decarbonization. Advancements in AI—including dynamic pricing, natural language processing for customer interaction, and predictive demand forecasting — augment these gains. Supported by broader industry evidence, this paper concludes that applying AI and mathematical optimization in concrete logistics is an indispensable enabler for building material producers striving for both net-zero goals and improved profitability.

From the Ground Up: The Concrete Case for Performance Care

Dr Fiona Crichton[1], **Sir John Kirwan**[1]
[1]Groov

Session 4, Kawau, October 17, 2025, 9:00 AM - 9:55 AM

With a kick off from Sir John Kirwan (All Black Legend & Mental Health Advocate), Dr Fiona Crichton (Groov) and Mike Botherway (Higgins Concrete) take the ball and explore how embedding Performance Care at work can lift safety, productivity, and culture.

In this entertaining and insightful session, the real-world benefits of Performance Care in industry are brought to life - from achieving 12 months without a lost-time injury, to building stronger team cohesion and enhancing a culture that adapts more effectively to challenges and change. The session will show how wellbeing at work has evolved beyond traditional “mental health” conversations into a practical, proactive approach to working well. Participants will gain actionable strategies to strengthen personal wellbeing and learn how these gains can cascade from individuals to the wider organisation and beyond.

The session will also highlight how this work doesn’t stop at the job site; that the culture of performance care extends outward - supporting not just employees, but their families, customers, and the healthcare system

Participants will leave with a deeper understanding of how performance care can be integrated into their own leadership and organisations - not just as a programme, but as a mindset. This is not about ticking a box; it’s about creating a culture where care equals performance - and everyone benefits.

Evaluating AS/NZS 2327 Provisions for Deep Deck Composite Slabs: Insights from Full-Scale Testing of ComFlor 210 Profiles

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Session 5A, Kawau, October 17, 2025, 10:00 AM - 10:40 AM

This paper examines the structural performance of deep deck composite slabs using ComFlor 210 profiled steel sheeting, based on full-scale testing conducted at Holmes Solutions to evaluate longitudinal shear resistance. The experimental program included specimens with spans of 3.6m, 5.4m, and 8.0m, subjected to both cyclic loading and static loading to failure, as per AS/NZS 2327 Appendix H. Results demonstrate that current provisions in AS/NZS 2327 for determining the longitudinal shear capacity require modification to accurately predict the behaviour of deep deck profiles, which can differ significantly from conventional shallow deck systems.

Analysis of the test data indicates that the m-k and partial interaction methods as currently formulated in AS/NZS 2327 fail to accurately capture the unique structural characteristics of deep deck systems, which fundamentally differ from conventional shallow profiles upon which the standard was primarily developed. This paper questions how AS/NZS 2327 might be adapted to account for these observations, exploring potential revisions to partial interaction design methods based on the testing completed at Holmes Solutions, as well as international research, and how specific longitudinal shear resistance values could be developed for deep deck profiles.

REVIEW OF STRUCTURAL CONNECTION DETAILS IN RECENTLY CONSTRUCTED MEDIUM-DENSITY HOUSING

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Session 5A, Kawau, October 17, 2025, 10:00 AM - 10:40 AM

Across New Zealand, there has been a growing trend toward higher-density housing in a variety of forms. Of particular interest are suburban apartments (typically 2 to 6 stories) with a scale that falls between traditional terrace housing and larger residential or commercial developments. With the rapid pace of construction, newly built structures incorporate various architectural layouts, structural systems, and construction materials. This diversity has resulted in the widespread use of novel structural connections and wall detailing, many of which have not previously been thoroughly examined or tested. In response to these concerns, over 60 recently constructed 2-6 storey apartment buildings were reviewed to identify representative connection types used across five major New Zealand cities. Most of these buildings utilized reinforced or precast concrete walls as the structural system and the review focused on connection types critical to their seismic performance, including wall-to-foundation, wall-to-wall, wall-to-floor, and beam-to-floor connections. The connection designs and detailing were sourced from council property files as well as precast concrete manufacturers and systematically categorized by connection type. The study reports on the frequency and characteristics of each connection type and discusses their respective advantages and potential concerns regarding their seismic behaviour. The findings offer insights into the prevalence of commonly used connection details in recently constructed concrete buildings and guide future experimental and numerical investigations aimed at validating and improving their seismic performance.

Calcined Clay Cement - A local Perspective

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Session 5B, Rangitoto, October 17, 2025, 10:00 AM - 10:40 AM

The production of cement accounts for ~ 8 % of the global anthropogenic carbon dioxide (CO2) emissions. Industrial process by-products such as ground granulated blast furnace slag, fly ash and silica fume, so called supplementary cementitious materials (SCMs), have been successfully utilized to reduce the clinker factor in cement for many decades. Due to the closure of coal fired power stations and the move away from blast furnaces for steel production these SCMs are becoming scarce. Calcined clay (containing phyllosilicates Kaolin and Illite) is an emerging technology, which has shown great promise as an SCM, particularly synergistic with limestone powder (limestone calcined clay cement, LC3) to produce a sustainable cement. A local perspective of the characteristics that define calcined clay for use as a supplementary cementitious material is given. Cementitious materials are complex systems and multiple variables must be considered through rigorous statistical analysis. Approximately 40 clays have been studied via techniques such as X-ray fluorescence (XRF) and X-ray diffraction (XRD) in order to elucidate a correlation of their fundamental chemical and physical properties with fresh and hardened performance in mortar/concrete.

Breaking Barriers: Empowering trades women to excel in the New Zealand Concrete Industry

Mr Greg Durkin[1], **Ms Amanda Williams**[1]
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Session 5B, Rangitoto, October 17, 2025, 10:00 AM - 10:40 AM

While many developed nations struggle to increase the participation of women in trades beyond 3%, New Zealand's Building and Construction Industry Training Organisation (BCITO) has achieved 6.3% of concrete industry apprentices in 2025, a significant increase from 2.1% in 2020.
BCITO is driving meaningful change by expanding critical discussions, resources, and practices that promote diversity and equity. Grounded in international research (Macisaac & Domene, 2014; Bridges, et al., 2020), BCITO's active interventions for women have contributed to research to better understand the needs of learners and employers - helping to shape a more inclusive concrete industry where tradeswomen remain and thrive.

The research paper describes how BCITO has worked collaboratively with employers in the NZ concrete industry to shift perceptions, increase opportunities, and lead remarkable change. We outline how a series of innovative initiatives created safe spaces for the industry to embrace and take responsibility for their own systemic change. This journey features key national milestones, including the Building Women's Framework (2018), Te Rautaki Mana Wahine - The Building Women Strategy (2022), and the Construction Accord Diversity Roadmap (2021).

Our paper also examines how BCITO continues to systematically evaluate its effectiveness through its Women in Trades Hub (capability-building tools, career guidance, mental health support) and national engagement campaigns, including Building Women's Stories and Hire Boldly (for employers). We will share how strategic partnerships with the construction industry helped make the magic happen.
By taking a people-centred approach that strengthens connections between apprentices, employers, trainers, and colleagues, BCITO is supporting concrete industry employers to dismantle gendered barriers and embed best practices on the frontline of industry. Our comprehensive analysis of challenges and successes highlights the positive impacts of these efforts, demonstrating how diversity and equity initiatives enhance work experiences and create lasting change within the sector.

Optimizing Steel Fibre Reinforced Concrete Performance: Spacing Theory and Application-Specific Safety Factors

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Session 6A, Kawau, October 17, 2025, 11:10 AM - 12:10 PM

This paper explores the critical role of fibre spacing in Steel Fibre Reinforced Concrete (SFRC) to achieve reliable performance. SFRC has transformed the construction industry by delivering significant efficiencies and improved tensile strength, crack control, ductility, post-crack performance, and enhanced durability compared to plain concrete, which is brittle and prone to cracking.

The effectiveness of SFRC depends on the reinforcement network and distribution of steel fibres, governed by fibre spacing. Spacing theory provides a methodical framework for understanding the relationship between fibre geometry (length and aspect ratio) and fibre dosage, ensuring a homogeneous composite material. It offers a mathematical model for determining the minimum fibre dosage required based on these factors and performance criteria. Key parameters include the aspect ratio (ratio of length to diameter) and fibre spacing (average distance between fibres). While distribution is central, fibre orientation also plays a significant role in stress redistribution.

Given the complexities of real-world applications, application-specific safety factors are crucial to ensuring material reliability. These factors compensate for potential inconsistencies in fibre distribution and address unique project performance requirements. Guidelines and standards such as EN 14487-1, AS 5100.5, and AS 3600 recommend safety factors to ensure adequate fibre overlap. The appropriate factor depends on the required performance level and quality control measures in place. Examples illustrate varying safety factors, such as higher values for jointless slabs.

Rigorous quality control is essential to meeting specified SFRC performance requirements. This includes defining fibre specifications, verifying fibre content and distribution (via washout tests or electronic methods), validating flexural strength when necessary, and maintaining comprehensive documentation. Responsibility is shared among fibre manufacturers, concrete producers, contractors, and project engineers.

In summary, optimizing SFRC performance and structural integrity requires a comprehensive understanding of spacing theory, the integration of application-specific safety factors, and the implementation of robust quality control measures.

Sustainable Long-Term Repair of Reinforced Concrete Structures using Galvanic encasements and Jackets

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Session 6A, Kawau, October 17, 2025, 11:10 AM - 12:10 PM

Reinforced concrete structures, when properly designed and maintained, can achieve long service lives, even in aggressive chloride environments. However, many such structures, including bridges, piers, and wharves, exhibit signs of corrosion such as rust staining and concrete spalling within as little as 10 years. If left untreated, chloride-induced corrosion can result in significant structural damage, often leading to costly and environmentally harmful demolition and replacement.

Extending the service life of existing structures is a sustainable and practical alternative. Benefits include direct cost savings for owners, reduced disruption to public services, and considerable environmental advantages such as minimized material use, decreased demolition waste and lower emissions.

One effective strategy for long-term repair is the use of galvanic encasements or jackets, which can provide both structural strengthening and cathodic protection in a single process. This dual-action approach is particularly suitable for severely deteriorated concrete structures on concrete piles for bridges and wharfs but also large concrete elements such as abutments and head stocks.

This paper presents case studies from New Zealand, Australia, and other international locations where galvanic encasement technology, that utilises distributed galvanic anodes, has been successfully implemented. Field data collected over more than 20 years will demonstrate that this method offers a sustainable and durable repair solution, capable of extending the service life of reinforced concrete structures by 20 to 30 years and beyond.

Effect of Hyperstatic Loads from Post-Tensioned Slabs on Columns and Walls in High-Rise Buildings

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Session 6A, Kawau, October 17, 2025, 11:10 AM - 12:10 PM

The use of post-tensioned slabs (PT slabs) in structural design is becoming increasingly popular due to their ability to span long distances, reduce the amount of reinforcement, formwork, and labor, thereby offering significant economic benefits. However, design practices often focus solely on the load-bearing capacity and deflection control of the slabs, while the reverse impact of hyperstatic loads, generated by the restraint of tendon forces, on the vertical structural system such as columns and concrete walls receives little attention. This represents a significant gap in design practice, especially when slab and vertical structure designs are often carried out independently by separate teams.

This paper presents a method for analyzing and evaluating the influence of hyperstatic loads, arising from the restraint of post-tensioning forces at supports, on the column and wall system in high-rise buildings. Using the specialized software ADAPT-FLOOR-PRO, models were developed to assess changes in internal forces, including axial force and bending moment at column positions, particularly at edge columns. The paper also includes analytical results from real-life projects in Vietnam, demonstrating that the influence of hyperstatic effects can be significant depending on the structural layout and tendon configuration.

Based on these findings, the paper proposes an integrated design approach: after analyzing the entire structure using specialized software, hyperstatic loads should be incorporated into the supplementary design of the vertical system. This method enhances the accuracy of structural design, which is particularly critical in complex high-rise buildings.

Performance of Concrete with Low Water Demand Pumice at Normal and Elevated Temperatures

Mr Kavishan Sathsara Ranatunga[1], Dr Enrique del Rey Castillo[1]
[1]The University of Auckland, Auckland, New Zealand

Session 6B, Rangitoto, October 17, 2025, 11:10 AM - 12:10 PM

Concrete is the most ubiquitous building material around the world because of its strength, durability, versatility and cost-effectiveness. Cement, the primary binder in concrete, significantly contributes to climate change through greenhouse gas emissions. To address this, the concrete industry is increasingly incorporating industrial byproducts as supplementary cementitious materials (SCMs). However, the demand for alternative SCMS is growing, particularly in non-industrial countries like New Zealand, due to urbanization and economic growth. This study investigates the potential of locally sourced pumice from the Taupo volcanic zone as a sustainable SCM. The pumice was ground using a ball mill and a ring mill to reduce internal porosity, as determined by the flow table test, which was used to replace cement in concrete mixes at levels ranging from 10% to 30%. To evaluate the pozzolanic reactivity with heat, concrete cylinders were cured for 28 days at normal temperature and elevated temperature. pH, temperature, and slump were measured as fresh concrete properties, and density, water absorption, compressive strength, and surface resistivity were measured as hardened concrete properties. A life cycle assessment (LCA) was performed as per the BS EN 15804+A1 (2013) to assess the environmental impact of concrete mixes.

Cradle-To-Cradle Life Cycle Assessment of Modular Concrete Gravity Retaining Walls: A Case Study on Emissions and Carbon Uptake Potential

Mr Osama Mughrabi[1], Dr Enrique del Rey Castillo[1], Dr Charlotte Toma[1]
[1]The University of Auckland, Auckland, New Zealand

Session 6B, Rangitoto, October 17, 2025, 11:10 AM - 12:10 PM

Governments worldwide are introducing regulations to reduce the environmental impact of various industries, prompting the concrete industry to seek more sustainable solutions. This study builds on a unique business model that upcycles fresh excess concrete to produce blocks for gravity retaining structures. To further capitalise on the waste concrete volume, we explored increasing the volume of collected excess concrete by 15% through the addition of various waste materials, with each waste material replacing a constituent of the typical mix design. Glass-based supplementary cementitious materials (SCMs) from construction and demolition waste (CDW) replaced cement, concrete slurry water replaced tap water, and recycled concrete aggregates and window glass sand replaced coarse aggregates and sand, respectively. Life cycle assessment (LCA) was performed throughout the project to evaluate the environmental performance from cradle-to-end of construction. In this study, a cradle-to-grave LCA was conducted on a gravity retaining structure built with modular concrete blocks. Two options were compared: blocks made from C20 fresh concrete and blocks made from the increased-volume excess concrete mix. Carbon uptake over a 100-year service life was included based on a model developed in earlier stages of the project. Results show that using the increased-volume excess concrete mix significantly reduced the total global warming potential (GWP) of the walls. Additionally, the study highlights the critical importance of accounting for carbon uptake in concrete LCAs.

Paving the Future

Mr Michel Abou Jaoude[1]
[1]Bosfa Pty Ltd, Sydney, Australia

Session 6B, Rangitoto, October 17, 2025, 11:10 AM - 12:10 PM

The construction industry is on the brink of a significant transformation with the introduction of SigmaSlab®, a revolutionary concrete reinforcement system that combines structural steel fibres and post-tensioning. This system allows for the creation of vast, seamless floors exceeding 150 meters without joints, offering not only enhanced functionality, aesthetics and reduced long-term maintenance but also substantial savings in time and cost. SigmaSlab® champions sustainability through a lower environmental footprint due to decreased steel and concrete consumption. This paper explores the technical aspects, design principles, and performance characteristics of SigmaSlab®, highlighting its real-world applications in diverse projects such as expansive warehouses, heavy-duty container pavements and elevated slabs. By merging post-tensioning and steel fibre reinforcement, SigmaSlab® achieves superior crack resistance and durability, presenting a paradigm shift in concrete construction. This system empowers engineers to design structures that are both functionally superior and environmentally responsible, heralding a new era of seamless floors, sustainable practices, and innovative solutions in the construction industry.

Solutions for shear performance of fixings with annular gap in accordance with international standards

Mr Andrew Coumaros[1], Mr Ronald Lumantarna[1], Mr Lachlan Hick[1]
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Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

Concrete structures built in the New Zealand construction industry often require fixings for various applications including steel supporting structures such as beam to wall and base plate connections, as well as for mechanical and electrical services. In any case, fixings into concrete encounter various load actions such as tension, shear, bending moments along with torsion. When dealing with any of the actions which subject the fixing to shear loading, it is easy to overlook the influence of the annular gap between the fixing and the hole diameter in the fixture has on the shear performance of the connection.

There are various international standards such as EN1992-4 (Europe), AS 5216 (Australia) and ACI 318 (US) which address the performance in a connection which encounters shear loading where the fixing is subject to an annular gap. In many cases, the design approach is very conservative when the annular gap is left unaddressed. However, when it is addressed, the load capacity in many instances can be significantly increased and/or potentially doubled.

This paper will go through the various international standards with respect to the design approach for when the annular gap is present along with the conditions each standard imposes to mitigate the gap and how to optimize the performance of the connection. Furthermore, the paper will look through various solutions that address the annular gap for both post-installed and cast-in connections and ultimately improve shear performance in static, quasi-static and seismic load conditions. This will provide clarity for Engineers and equip them with knowledge to optimise their designs.

The Britomart Skylid: Design and Construction Considerations

Mr Adnan Ahmed[1]
[1]Aurecon, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

This presentation explores the design and construction of a unique architectural and structural element within the new Britomart plaza, scheduled for completion in September 2025. The project faced numerous constraints, with the feature positioned adjacent to the wharf designed for IL3 100 years crowd-loading. The talk will outline the key challenges encountered and the innovative solutions adopted.

Design of Westpoint Drive

Marco Chui[1]
[1]DHC Consulting Group, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

A commercial development of four warehouses and three offices, sharing challenges, key learnings, and insights on how senior engineers can help early-career peers thrive.

Streamlining Concrete Mix Design and Business Efficiency with an AI-Powered Excel Application

Mr Nick Kerr[1]
[1]Consulthub Ltd, 10 Eric Price Ave, Takapuna, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

Concrete mix design is a critical factor in achieving performance, sustainability, and cost-efficiency in the concrete industry. This paper presents a scalable and practical solution: an AI-powered Excel application developed to streamline concrete mix design and optimisation processes for ready-mix and precast concrete businesses. The tool enables engineers to create new concrete mixes, optimise existing recipes, and manage essential performance, cost, and sustainability metrics, within a secure, familiar, and user-friendly platform.

The application includes a built-in database of key materials such as sand, coarse aggregates, cement, SCMs, admixtures, fibres, and additives. It guides users through calculating mix proportions based on water-binder ratio (W/C), targeted strength, and ideal grading curves. The tool automates critical steps, including aggregate blending, material volume calculations for 1 m^3 of concrete, and pre-trial sheet generation. For self-compacting concrete, it balances materials based on volume. After trial mixes, the application adjusts the recipe to ensure accurate yield and batching.

The tool also calculates the cost and CO_2 footprint of each mix, provides sustainability benchmarking, and generates detailed visual reports and dashboards for quick analysis and decision-making. Historical mixes can be easily retrieved, reviewed, and refined.

Built entirely in Excel with AI-powered automation, the solution ensures accessibility, data security, and seamless integration without third-party software. It keeps all data centralised, private, and easy to update. While focused on mix design, similar AI-powered Excel tools can support broader business functions such as quality assurance, internal audits, and cost control.

This paper will outline the development process, demonstrate the application's capabilities, and highlight how digital tools like this can help concrete businesses operate more efficiently, reduce environmental impact, and improve overall quality and performance.

The Repair of a Dilapidated Concrete Wing Wall

Mr Matthew Thornton[1]
[1]Downer NZ, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

This short presentation will outline one of Matthew's projects. The existing wing wall was cracked in several places and at risk of collapse. The proposed repair, designed by others involved re-construction of the slab and the pouring of a wall overlay. Matthew designed restraining temporary works to provide safe access consisting of a prop and steel brackets. Propping was complicated by the fact that the slab had be re-poured before the repair of the wall. Single sided formwork was required for pouring the wall overlay with ties fixed into the existing wall. Matthew took the lead for the construction method and temporary works which ended in a successful result.

Detailing and Coordination in the Design of the Silverstream Landfill Stormwater Chute

Mr Tony Wang[1]
[1]Tonkin + Taylor, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

This presentation explores the detailed design of a stormwater chute at the Silverstream Landfill, comprising a reinforced concrete (RC) slab on slope with baffles, shotcrete facing, and RC wing walls. The focus will be on design detailing for constructability and durability, as well as the multi-disciplinary coordination required to achieve an integrated and practical design outcome.

Challenges and prospects of mussel shell pozzolanic binder in Aotearoa New Zealand

Mr Thomas D. Kishore[1], Dr Enrique del Ray Castello[1], Professor Jason Ingham[1], Dr Emilee Benjamin[2]

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Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

The global construction industry faces mounting pressure to decarbonise, with Aotearoa, New Zealand, targeting net zero greenhouse gas emissions from cement and concrete by 2050. The decarbonisation roadmap targets a 28% reduction in emissions, which is expected from replacing conventional cement binders with low-carbon alternatives and supplementary cementitious materials. In line with this target, this study explores the potential of using mussel shell by-product and naturally abundant pumice, both of which are available in New Zealand, as sustainable binders.

Over 55,000 tonnes of mussel shells are discarded annually as aquaculture by-products, while extensive pumice reserves remain underutilised across the North Island. The aim of this research is to investigate the challenges of utlising these materials for an alternative binder, similar to Roman concrete, focusing on the chemical compatibility and pozzolanic reactivity. To understand this, mussel shells, rich in calcium carbonate, were thermally treated, while pumice was mechanically ground and characterised using XRD, SEM and TGA analysis. The two materials were then combined in varying ratios and tested in mortar samples for compressive strength and setting time.

The results demonstrate that mussel shell and pumice blends exhibit promising pozzolanic activity but achieve lower strength when compared with conventional Portland cement binders. Moreover, challenges remain, including the high processing cost and time for both materials and tailored mix design, which are necessary to ensure consistency.

This study highlights a promising strategy for reducing emissions in the Aotearoa New Zealand construction sector through valorising local by-products and natural resources, directly contributing to national decarbonisation goals and supporting the transition to more sustainable infrastructure materials.

From Structure to Surface: Exploring the Aesthetic Potential of Functionally Graded Concrete in Architecture

Miss Lisa Lin[1]
[1]University of Auckland, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

Lisa's thesis investigates the aesthetic potential of FGC as an architectural material for building component integration. The study examines FGC from two key perspectives: material expressiveness and structural logic.

Mg-based Binder Systems with Inexpensive Aluminosilicates for Terrestrial and Off-Earth Applications

Mr Banujan Balaskandan[1]
[1]University of Canterbury, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

The search for environmentally friendly concrete has resulted in a number of innovative and potentially viable binder options. Several Mg-based binder systems are studied, and the beneficial incorporation of aluminosilicates with reactive magnesia (MgO) has been widely reported. Metakaolin (MK) is a highly reactive supplementary cementitious material (SCM) that has been examined in Mg-based binders; however, there are practical implications as MK is relatively expensive and high-water-demanding. The current study utilises locally available, low-cost, and less water-intensive aluminosilicates to produce Mg-based binders that is suitable for both terrestrial and off-Earth applications.

Concrete with Pumice: Economic Insights and Consumer Preferences

Dr Stefania Mattea[1], **Dr Nicola McDonald**[1]
[1]Market Economics, Auckland, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

Concrete is fundamental to the built environment, yet there is growing interest in options with lower environmental impact. This talk draws on research from the MBIE-funded Ngā Ara Pungapunga project to explore industry and consumer preferences for concrete mixes using natural pumice as a partial cement replacement-offering potential to cut emissions while maintaining performance. Based on a survey of over 300 professionals and homeowners, we examined trade-offs between performance, cost, emissions, certification, and sourcing. The findings reveal what drives demand, what deters adoption, and where opportunities lie, bringing an economic lens to the future of concrete in Aotearoa's low-emission transition.

Overview of the O2NL Project

Miss Ivy Hua[1]
[1]WSP, New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

Focus on the Ōhau River Bridge - a 200m, five-span, prestressed concrete bridge built with SuperHi girders, carrying four traffic lanes and a SUP. She will also briefly discuss key design challenges, particularly the impact of significant soil displacement on the structural design.

WSP’s Low Carbon Concrete Guide

Fraser Beggs[1], **Ms Izzy Cattermole**[1]
[1]WSP New Zealand

Session 7, Kawau, October 17, 2025, 1:10 PM - 2:25 PM

Izzy and Fraser are working on the development of Revision 4 of WSP’s Low Carbon Concrete Guide, a practical resource for specifying and implementing lower carbon concrete in buildings and transport infrastructure. Their presentation will outline strategies for reducing embodied carbon through design efficiency, material selection, retrieving EPD data from suppliers, supported by specification templates and baseline data for use in designs across the business to help achieve WSP's carbon footprint commitment.