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BUILDING RESILIENCE

BOOK OF ABSTRACTS




14 November 2024
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City Rail Link: Te Waihorotiu Station – Sustainability in Design and Construction.

Mr Ethan Page[1]
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City Rail Link: Te Waihorotiu Station – Sustainability in Design and Construction, Auditorium, November 14, 2024, 8:50 AM - 9:10 AM

The City Rail Link engaged Link Alliance to design and build all station structures on Auckland's $4.4billion underground metro extension project.

The structures include two new underground rail stations - Te Waihorotiu located beneath Albert Street, extending between Wellesley and Victoria Streets, and Karanga-a-Hape, between Beresford Square and Cross Street. The existing Maungawhau/Mount Eden surface station is to be redeveloped, and twin bored tunnels will connect the stations extending from Albert Street to Maungawhau where they bifurcate through a grade-separated interchange.

The City Rail Link is the largest public transport infrastructure project ever to be undertaken in New Zealand. It is estimated that it will allow the current rail network to at least double in capacity to cope with 54,000 passengers an hour at peak travel times, and is the catalyst for reshaping a vibrant and sustainable city for people to live in.

This paper focuses on the sustainability objectives of the City Rail Link project and aligning these with cultural, industry, and global initiatives to positively contribute to the environment and society. This paper will discuss the controls adopted to achieve the project's sustainability targets during the design and construction of Te Waihorotiu Station's concrete underground structure, and review the lessons learnt that can inspire the future of sustainable concrete design in major infrastructure projects.

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A-Z of Sustainable Concrete

Mr Tim Kleier[1]
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Lightning Talks, Auditorium, November 14, 2024, 9:40 AM - 10:30 AM

The concrete industry recognises its responsibility to reduce emissions and is implementing tangible steps toward net zero. Meanwhile, competing materials are gaining attention for their lower emissions. However, focusing solely on carbon reduction risks ‘impact leakage’—a shift in attention that could overlook broader environmental impacts. As highlighted by the UN, biodiversity is “our strongest natural defence against climate change.” Similarly, Sir Robert Watson and author Lyle Lewis emphasise the equal importance of biodiversity in safeguarding our planet. Tim Kleier’s talk will explore environmental impacts beyond carbon, advocating for a more comprehensive approach.

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Design trends in green roofs engineering

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Lightning Talks, Auditorium, November 14, 2024, 9:40 AM - 10:30 AM

Green roofs have emerged as a dynamic and versatile solution to the environmental challenges facing urban areas. As the demand for sustainable infrastructure continues to rise, designers and engineers are exploring innovative approaches to green roof engineering that prioritize functionality, aesthetics, and ecological resilience. Several design trends are shaping the evolution of green roofs, driving forward the integration of nature into the built environment while enhancing their performance and impact. Here are some key design trends in green roofs engineering which were analysed in the paper:

- Prefabricated and modular systems: prefabricated green roof systems are gaining popularity due to their ease of installation, scalability, and flexibility. These systems consist of pre-assembled modules or trays containing soil, vegetation, and drainage components, allowing for rapid deployment and customization to fit various architectural configurations.
- Stormwater management: Blue-green roofs, also known as hybrid green roofs, combine elements of traditional green roofs with water retention and reuse systems to enhance stormwater management and water efficiency.
- Biodiversity-focused designs: Traditional green roofs often feature a limited selection of plant species chosen for their hardiness and suitability to rooftop conditions. However, there is a growing emphasis on biodiversity enhancement, with designers incorporating a wider range of native and pollinator-friendly plants to support local ecosystems.
- Smart technology integration: Incorporating sensors and monitoring systems to optimize irrigation, track plant health, and improve overall green roof performance.
- High-Performance Green Roofs: High-performance green roofs are designed to optimize multiple environmental benefits, including energy efficiency, stormwater management, air quality improvement, and biodiversity conservation.
- By incorporating these design trends, engineers can create innovative and sustainable green roof solutions that address environmental challenges and contribute to the development of resilient and eco-friendly urban landscapes.

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Effects of SCMs on Coloured Concrete

Stu Hunter[1]
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Lightning Talks, Auditorium, November 14, 2024, 9:40 AM - 10:30 AM

SCMs (Supplementary Cementitious Materials) are additives that partially replace cement in concrete to (in part) reduce CO2 emissions. Common examples are Fly Ash, Slag (GGBFS) and Silica Fume. The use of SCMs in concrete can have a range of impacts (e.g. workability, curing time, surface finish and durability) and therefore the final outcome of coloured concrete. The use of SCMs is set to grow as the global concrete industry looks to decarbonise, so find out what you need to know to achieve the best colour finish

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Mechanical properties of the geopolymeric binders based on power plants' fly ashes

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Lightning Talks, Auditorium, November 14, 2024, 9:40 AM - 10:30 AM

In line with European Union guidelines, Poland has made efforts to modernise existing power plants, increasing the capacity of renewable energy sources and improving energy efficiency, which is essential to address environmental concerns and meet climate change targets. Over the past two decades, the share of coal-fired power stations in electricity generation has fallen by more than 30% (to 63% in 2023). Nevertheless, coal- and lignite-fired power plants are among Poland's largest producers of CO2 released into the atmosphere and producers of waste that is a by-product of combustion.

The paper presents a study of the mechanical properties (mainly focused on compressive and flexural strength development) of various geopolymeric binders based on different fly ashes obtained from two lignite-fired power plants and one hard coal-fired power plant. These geopolymeric binders based on power plants' fly ashes offer a promising alternative to conventional cementitious materials, showcasing favourable mechanical properties that make them suitable for a wide range of construction applications. These binders are synthesized through the alkali activation of fly ash, resulting in the formation of geopolymer gels that provide cohesion and strength to the material. The mechanical properties of geopolymeric binders derived from power plants' fly ashes are influenced by various factors, including the chemical composition of the fly ash, the alkaline activator formulation, curing conditions (time and temperature of heat curing), and the presence of additives.

In summary, by understanding and optimizing these mechanical properties, geopolymeric binders based on power plant fly ashes can be tailored for specific applications, offering sustainable and high-performance alternatives to traditional construction materials. This can contribute to reducing the amount of waste generated annually by power plants, which will of course benefit the environment as part of a circular economy.

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Introduction of non-destructive testing (NDT) equipment for quality control of concrete structures, with a specific focus on ultrasonic testing.

Mr Mohammad Mottaghi[1]
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Lightning Talks, Auditorium, November 14, 2024, 9:40 AM - 10:30 AM

Quality control is an essential consideration, without which no construction operation can proceed smoothly. Concrete, being a favored material for construction, requires assessment at various stages: before casting, during casting, after hardening, and during its service life.

While traditional equipment such as compression machines has long been used to verify concrete's required compressive strength, there are situations where assessing overall concrete quality is necessary without performing destructive tests. This is where non-destructive tests play a crucial role, including methods like Schmidt hammers, ultrasonic testers, corrosion meters, and pull-out/pull-off testers.

Schmidt hammers have a significant history in the market, yet debates persist regarding their accuracy and practical application. Additionally, newer ultrasonic testers face skepticism within the engineering community as a reliable assessment tool.

In this context, I will introduce non-destructive tests for concrete structures and delve into the usage and principles of both Schmidt hammers and ultrasonic testers. My focus will be on the ultrasonic test, exploring how it assesses various concrete parameters and how combining the results of these two equipment can enhance the accuracy of non-destructive test results.

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A Hard Road to Hoe

Mr Bernie Napp
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Lightning Talks, Auditorium, November 14, 2024, 9:40 AM - 10:30 AM

Cash-strapped roading authorities are largely ignoring an obvious alternative to asphalt. Concrete is cheaper, has a longer life, less need for maintenance, and lower whole-of-life embodied CO2. While a foray is underway in Tauranga and Hamilton using roller-compacted concrete (RCC), uptake of RCC or any concrete roading method in New Zealand is almost non-existent. That flies in the face of concrete’s common use overseas in roading. Public consultation earlier this year on a "Draft Government Policy Statement On Land Transport 2024-2034" offered an opportunity to shift the dial on the concrete/asphalt debate. The Government seeks more value for money in the roading network, fewer potholes, and fewer road repairs. Dear Minister, concrete is here to help!

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PAP7, Particle Packing and the Pareto Principle in Concrete Technology

Dr James Mackechnie[1]
[1]Allied Concrete, University of Canterbury, Christchurch, New Zealand

Session 2A, Bealey 4 & 5, November 14, 2024, 11:00 AM - 12:30 PM

PAP7 (Premium All Passing 7mm aggregate) was synonymous with a high-quality manufactured sand that was blended with natural sands from marine or alluvial sources to make up the fine aggregate component of concrete. The assumption of quality of PAP7 has been questioned in recent years with some materials exhibiting poor shape and deleterious fines, leading to lower performance of concrete. This paper seeks to quantify the material and environmental cost of using manufactured sands that are below optimum and what alternatives exist to improve the material. The research explains how manufactured sand affect both water demand and particle packing of concrete, that controls compressive strength. It also attempts to invert the current thinking in concrete technology where the cementitious paste content is generally assumed to control the properties of concrete (e.g. synonymous with the Pareto Principle). Various PAP7 sources were analysed and compared with modern manufactured sands, often referred to as engineered sands, in terms of their physical characteristics and the performance in concrete mixes. Testing was also undertaken to identify how particle shape and texture of manufactured sand affects particle packing in concrete, with concrete microstructure being characterized using density, porosity and permeability. Initial findings from this research show that using lower quality PAP7 in concrete may result in a 15-20% increase in baseline cementitious content compared with concrete using high quality manufactured sand. This research also discusses three mechanisms that help to optimize the strength of concrete; namely controlling water demand, reducing adsorption effects and better particle packing. Recommendations are also made about simple characterization protocols for manufactured sands and their blends that allow quick and reliable assessment during concrete production.

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Leaching Potential of Silicomanganese Fume Used as Supplementary Cementing Material in Concrete

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Session 2B, Auditorium, November 14, 2024, 11:00 AM - 12:30 PM

The construction industry continually seeks sustainable alternatives to improve concrete performance while minimizing environmental impact. One key strategy involves the use of supplementary cementitious materials (SCMs). SCMs are used in conjunction with Portland cement, resulting in improved concrete properties and helping to reduce carbon footprint. Different SCMs used in cementitious composites include silica fume, metakaolin, silicomanganese fume (SMF), fly ash, and slag. These substances are either pozzolanic or hydraulic, reacting with portlandite (a cement hydration product) to form secondary hydration products. The utilization of SCMs in concrete can improve strength, durability, and sustainability by modifying its microstructure, hydration products, and pore characteristics. SMF, a byproduct of the steel-making industry, is produced in millions of tons every year and has been used readily in the construction industry in recent years. However, there is potential harm to inhabitants due to the presence of heavy metals, like Manganese, in SMF. In this study, the leaching characteristics of Manganese from SMF-based cement paste samples have been evaluated. SMF was used to replace cement in different proportions (10%, 20%, & 30%), and the resulting mechanical properties and leaching characteristics were studied by compressive strength testing and ICP-MS analysis at different intervals over three months. The results show that there is a minimal amount of leaching within two days of leaching and no leaching over the long run. The compressive strength results show that there is a decrease in strength with increasing SMF content over 20wt%.

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Traceability and Compliant Reinforcing Steels

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Session 2B, Auditorium, November 14, 2024, 11:00 AM - 12:30 PM

The reinforcing steels placed in our concrete structures are essential in ensuring the safety and resilience of these structures. With an increasing supply of reinforcing product being imported to supplement local manufacturing there is an elevated necessity to ensure that all product meets the standard. The material standards AS/NZS 4671 outlines the minimum requirements for these steels which include chemical properties, material properties, geometric properties and requirements for traceability of the product. The standard also identifies what additional measures are required through the manufacturing of products and downstream processing.

The standard states the traceability along with ongoing testing during manufacturing and processing of reinforcing products are key components that need to be demonstrated for reinforcing steel products to be compliant. So what are the key requirements that should be looked for when determining if the reinforcing product delivered to site is in fact compliant. This paper will outline what the requirements for reinforcing materials as detailed in the New Zealand standards are, how properties of materials are altered during downstream actions such as the bending and cutting scheduling process. Then show what engineers and procurers of product need to do to ensure the delivery of compliant materials, along with what checks should be conducted upon delivery of the product.

The paper will also outline current methods being rolled out across the globe to enable digital traceability and product verification at a batch level, giving the specifiers, designers and certifiers confidence the product being delivered meets the requirements of the product specified.

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Lower embodied carbon design with concrete bridges

Mr Kwan Chin[1], Hanna Davidson
[1]WSP, Hamilton, New Zealand

Session 2B, Auditorium, November 14, 2024, 11:00 AM - 12:30 PM

With carbon reduction being a major focus in infrastructure design work, finding efficient ways to design with lower embodied carbon has become a priority. With that in mind, a benchmarking exercise was undertaken carrying out life cycle assessments on a sample of bridges to find any observations that could assist efforts to reduce embodied carbon in design.

The sample comprised 32 bridges, primarily in the Auckland and Waikato regions, with 2 others in the Central North Island and two in the South Island. Structure types included concrete, steel and steel composite bridges. Total structure lengths ranged from 18 to 305m, with span lengths between 12 to 60m. Life cycle assessments on each structure were conducted covering modules A to D, following the MBIE Whole of Life Embodied Carbon Assessment Technical Methodology Guidance.

The benchmarking results demonstrated the benefits of using super tee and hollow core beams were not only economic but also resulted in less embodied carbon in general. This paper explores whether existing standard super tee and hollow core beams can be further optimised, and whether the use of alternative prestressed beams can lead to further reduced embodied carbon.

It was also observed that substructure arrangements had a significant impact on the embodied carbon, with multiple-column substructures tending to be more carbon-efficient than monopile substructures. Other ways to reduce embodied carbon were also explored, such as optimising the crosshead width in integral bridges, or the use of post-tensioning.

Reinforcing steel was also a significant factor increasing embodied carbon. The lack of recycled reinforcing steel in New Zealand means a higher carbon intensity compared to imported steel. International guidance often recommends adding more reinforcing material to reduce embodied carbon. In New Zealand this guidance is less applicable, with concrete being a less dominant carbon contributor at present.

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Connecting communities via post tensioned concrete - Te Papa Ōtākaro Avon River Precinct, North Frame Pedestrian Bridge

Mr Jeremiah Shaw[3]
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Session 2B, Auditorium, November 14, 2024, 11:00 AM - 12:30 PM

As part of the Te Papa Ōtākaro / Avon River Precinct upgrades and beautification, Ōtākaro Limited had an objective to increase the walking and cycling connections in the central Christchurch river front area – one of the connections was a new bridge over the Ōtākaro Avon River linking the North Frame to Victoria Square.

Beca completed the design of the North Frame Pedestrian Bridge from concept options through to Issue for Construction. Concept options were prepared with multiple material types and span arrangements. Concrete was selected as the preferred material type for its limited maintenance, operational costs and resilient design. The bridge is a 32m concrete post-tensioned 2 span bridge providing a 3.5m-wide walking and cycling crossing over the Ōtākaro Avon River and is supported on bored concrete piles. It was cast in-situ in a single pour, then post-tensioned to carry the weight of the bridge and design loading.

The asymmetric span arrangement and varying depth post tensioned concrete section was specifically designed to reduce the overall concrete, minimising the projects carbon footprint.

The bridge deck features two different concrete textured bush hammered finish representing the movement of the river beneath. Set within the textured walking surface of the bridge deck are 28 basalt stone disks expressing the cultural narrative of the Ōtākaro Avon river. The granite disks are etched with images of native plants and animals created by artist Piri Cowie (Kāi Tahu, Ngāpuhi, Ngāti Kahu) working with Matapopore Charitable Trust to share Ngāi Tūāhuriri pūrākau (stories).

The bridge is open and used by pedestrians and cyclists. It serves as a valuable asset for the city of Ōtautahi Christchurch, acting as a unifying force that connects communities. Additionally, it serves as a stunning testament to a natural environment and the use of concrete whilst encapsulating beauty and storytelling.

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Concrete Industry Apprenticeships – strategies for successful retention and completion

Mr Greg Durkin[1], Mr Adam Barker[1]
[1]BCITO, Wellington, New Zealand

Session 2B, Auditorium, November 14, 2024, 11:00 AM - 12:30 PM

Training and retention of skilled staff is critical to the success of the NZ concrete industry. Apprenticeships play a key role in ensuring the industry's workforce has the skills and knowledge to deliver high-quality outcomes in all facets of construction and infrastructure. In our constantly changing world, it is vital to cultivate a dynamic and future-ready workforce. In recent years, construction has experienced a broad range of external and internal change factors that caused considerable instability for employers and staff, e.g. global pandemic, building boom, recent economic contraction, etc. While recent growth provided greater opportunities for profitability and employment, issues with staff retention have also increased markedly.

BCITO has seen a marked surge in active apprenticeships from over 11,000 in 2018 to 18,500 in December 2023. However, there has also been a corresponding – if not larger: increase in withdrawal numbers prior to apprenticeship completion; an increase in the proportion of withdrawals in the early stages of training; and slight decrease in programme completion rates.

To unravel the underlying dynamics driving apprentice retention, and build interventions alongside industry, BCITO (in partnership with Scarlatti) embarked on a comprehensive study of apprentice retention in late 2023 and early 2024. This action-research project uses a mixed-method approach by leveraging government quantitative data analysis, apprentice and employer interviews, and collaborative workshops with apprentices, employers, and BCITO staff.

Join us as we delve into our research approaches, findings, and interventions. We will share practical steps arising from the study and how BCITO is supporting the concrete industry to retain talented apprentices in a time of complex change.

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Pervious Concrete

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Session 3A, Bealey 4 & 5, November 14, 2024, 1:30 PM - 3:00 PM

The rising urbanisation trends have led to increased impermeable pavements, increasing the demand for efficient stormwater management solutions. Pervious concrete is a type of pavement designed with high void content and can be a sustainable alternative for managing stormwater. Its interconnected void structure allows for high water infiltration rates, reducing runoff and mitigating the need for expansive stormwater infrastructure. Pervious concrete is primarily applied in light vehicular and pedestrian pavements and its unique characteristics require specific design, compaction, and curing methods to maintain structural integrity and functionality. Key properties including density and void content, are crucial for its performance and longevity, with regular maintenance to prevent clogging and preserve permeability. Additionally, clarity of responsibilities among stakeholders including site contractors, installers, and concrete producers, is essential to ensure the pavement functions as intended throughout its service life. This paper also includes the recent updates to the Concrete NZ Readymix Technical Note 9 on pervious concrete, recently reviewed by various concrete industry members. The revised version, now in its final stages of publication, aims to provide improved guidance for suppliers, placers, and end-users, supporting the successful application of pervious concrete.

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Green & Sustainable Construction with Recycled & High Strength Steel

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Session 3A, Bealey 4 & 5, November 14, 2024, 1:30 PM - 3:00 PM

Carbon emissions are harmful to global warming and it's hitting new highs. Built environment is estimated to contribute about 38% to the global warming. For many years' major focus was placed on operational carbon however up to 40% of the carbon emission in a building is estimated to be from the embodied carbon or the carbon footprint of the building and this number is expected to rise as operational carbon is being optimized. Steel, Concrete and Glass are estimated to be the major contributors of the carbon footprint of a building of which steel is estimated to contribute a major share. While majority of the steel production in the world is based on burning coal the focus is now shifting to greener energy and recycled steel. Using recycled steel products and high strength steel such as Grade 600 reduces the carbon footprint of the building considerably. To be effective, these recycled products need to be considered upfront in the concept / design stages. Various tools are available to the Engineers to make an informed decision while choosing building materials for a project upfront, before construction. This paper delves on these aspects and demonstrates how to build with a lower carbon footprint with material circularity and inclusivity in focus. Climate change is already happening, and we need to act fast before it's too late to save ourselves.

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Low carbon cement replacement

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Session 3A, Bealey 4 & 5, November 14, 2024, 1:30 PM - 3:00 PM

This paper explores best practices for low-carbon cement replacement globally, highlighting the role of supplementary cementitious materials. It also examines the use of Environmental Product Declarations (EPDs) and international strategies for Carbon Capture, Utilization, and Storage (CCUS), as well as carbon uptake to mitigate the environmental impact of concrete.

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Seismic design of post-installed fasteners in New Zealand

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Session 3B, Auditorium, November 14, 2024, 1:30 PM - 3:00 PM

Majority of the NZS 3101 Concrete structures standard is rooted in ACI 318, however, it recommends European standards (EN) and other documents (EOTA TR) for design and assessment of post-installed fasteners, since 2017. The relevant ACI codes (ACI-CODE 355.2 and 355.4) are under substantial development in 2024, and ACI-CODE 318-25 is expected to address those changes too. Most important update is that the fastener assessment method known in New Zealand as "C1" has been omitted from ACI codes and the fastener assessment method known in New Zealand as "C2" has been suggested. This improvement is welcome since the method "C1" has been proven to be inferior for seismic assessment, demonstrated by multiple scholars in the literature. NZS 3101 should follow this good example and the EN and EOTA references that include the allowance for assessment method "C1" need urgent replacement in NZS 3101. Despite the more than 20 years research of the topic, seismic design of fasteners is still an underdeveloped practice both in ACI and EN codes. The fastener capacities available from product assessment are very loosely connected with the design seismic demands. Seismic fastener design can be either overly conservative or unsafe due to the disconnection between fastener assessment and design. This paper provides an analysis of these details and introduces the fastener assessment method currently known in New Zealand as "C2" in the context of the DZ TS 1170.5-2024 Public Comment Draft. An analysis for possible directions in the improvement of seismic fastener design in New Zealand is also provided.

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Seismic Testing of cast-in and post-installed anchors with a commercially available tolerance enabling device

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Session 3B, Auditorium, November 14, 2024, 1:30 PM - 3:00 PM

It is common that post-installed anchors encounter locations in the concrete where reinforcement interferes with their installation. In some cases, the initial hole can be discarded, and the anchor can be re-installed where reinforcement does not interfere. On the other hand, there are many cases where the prefabricated fixtures do not provide this flexibility and costly modifications are required. Furthermore, it is common that cast-in anchors encounter location tolerance challengers and are often discarded for a post-installed solution.

To provide a more cost-effective solution to the above, a commercially available tolerance enabling device was introduced. For post-installed anchors, this enables the flexibility of re-installing the anchor without having to modify the existing prefabricated fixture. For cast-in anchors, this enables better utilisation due to the increase location tolerance and eliminating any need to discard the anchor. Both post-installed and cast-in anchors have been extensively tested in concrete. Furthermore, the commercially available tolerance enabling device has also been tested with steel bolted connections and cast-in ferrules and design data published accordingly. Extending on current data tested, the device has now been tested with commercially available post-installed anchors and cast-in anchors to address the gaps in performance and/or to complement existing published information.

The testing regime is focused on the main performance gaps identified when introducing the tolerance enabling device to the system. Therefore, the testing regime only investigates shear performance of the Post-installed/Tolerance Enabling Device System as the tensile performance remains unaffected. It includes shear performance for category C1 and C2 seismic test regimes. It also includes static shear testing in concrete and all results are compared with the existing published data.

The results of the testing have provided designers with a performance-based solution for both post-installed and cast-in anchors when used with a commercially available tolerance enabling device.

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Counterfort Walls and Maximising Pedestrian Spaces in Queenstown

Mr Nick Hann[1]
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Session 3B, Auditorium, November 14, 2024, 1:30 PM - 3:00 PM

The St Josephs Wall is a 5m-tall reinforced concrete counterfort wall constructed as part of the Arterial Stage 1 project for the Kā huanui a Tāhuna alliance. The alliance is made of Beca, WSP, Downer and Fulton Hogan, along with the two owner participants NZTA and QLDC. The Arterial Stage 1 project is part of a road bypass around Queenstown’s town centre.

Through the design optioneering phase, multiple retaining wall types were considered including anchored walls, secant pile type walls and a counterfort concrete wall. Due to land access limitations, a concrete counterfort wall was preferred as it would minimise the land required for the permanent works whilst maximise the usable space for the roadway and pedestrian footpath in front of the wall.

The unique concrete counterfort design is approximately 80m long and comprises piled and non-piled portions. All piles were constructed as open bore reinforced concrete piles to a depth of 7.0m to 9.5m. The reinforced concrete footing and counterforts were constructed in-situ, whereas the wall facing was constructed using precast concrete. The precast concrete panels feature an intricate sandblasted and stained artwork designed by local artists featuring embedded pounamu (greenstone) tiles.

The St Josephs Church building situated directly behind the counterfort wall is a Category 2 listed heritage site and introduced construction challenges and constraints . This presentation will present one of the largest concrete counterfort walls in NZ, challenges during construction and how the resilience of a concrete structure achieved the desired project outcomes.

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3D Modelling Reinforcing Steel - A new resource for Safety & Quality

Mr Christo Erasmus[1]
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Session 3B, Auditorium, November 14, 2024, 1:30 PM - 3:00 PM

Background:
The reinforcing steel industry has long been synonymous with a gritty, hands-on approach, where black steel is shaped, bent, and encased in concrete. Yet, traditional detailing methods are rife with manual processes prone to errors and safety hazards on a construction site. Enter 3D modelling technology, a game-changer poised to revolutionize this industry. This technology offers not only the ability to enhance safety but also to improved quality and collaboration among stakeholders.

Aim:
This study delves beyond the surface to explore the health and safety benefits of integrating 3D modelling in reinforcing steel practices. It zeroes in on the advantages of sharing these models with involved parties in construction projects. The research aims to highlight technology's potential not just for safety enhancement but also for fostering superior coordination among project contributors.

Methodology:
Our approach blends project reviews and case studies. We scrutinize conventional manual detailing methods versus 3D modelling technology, pinpointing safer construction approaches. We delve into real-world case studies where shared 3D models have been implemented, and analyze stakeholder feedback regarding the technology's impact on safety, quality and collaboration.

Results:
Initial findings underscore significant safety and quality advantages linked to utilizing 3D modelling technology for reinforcing steel and sharing the resulting models with stakeholders. These shared models, accessible via a cloud platform, offer precise representations of the steel arrangements, streamlining review processes and bolstering coordination and decision-making. Consequently, errors and conflicts are minimized, stakeholders are spurred to explore off-site prefabrication options, reducing on-site hazards.

Conclusions:
Our study underscores the profound safety and quality benefits of leveraging 3D modelling technology in construction projects. Furthermore, shared 3D models foster collaboration, transparency, and efficiency throughout the review process. Embracing this technology is paramount for cultivating a safety-driven and innovative culture in construction, leading to superior project outcomes and enhanced worker well-being.

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Parametric Analysis to Determine the Connection Capacity of the Headed Stud Joint Connection in Steel-Prestressed Concrete Hybrid Girder

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Session 3B, Auditorium, November 14, 2024, 1:30 PM - 3:00 PM

Through previous research, an innovative hybrid girder for a bridge application by embedding a steel girder of a composite girder in a prestressed concrete girder cross section for a certain length has been adopted to vary the load capacity along the length of the girder. In the hybrid girder, headed stud shear connectors devise the anchorage zone/ joint connection. It is considered to have greater capacity in the joint connection than the other segments, but there is no way to verify its capacity. The present contribution aims to analytically study the critical parameters of the joint segment to be configured to verify the load-bearing capacity of the joint experimentally. A parametric analysis was conducted to reduce the effect of uneven shear force distribution along the shear connection, which is a fundamental issue when designing a joint connection of a steel-concrete composite element connected to a prestressed concrete element in the anchorage zone of the hybrid girder. The mechanical model for parametric analysis is emphasized so that the critical parameters having a quantitative and qualitative influence on the shear force distribution in the connection are discussed. The influence of the number of shear connectors, length of the joint connection, and stiffness of the shear connectors and the connecting elements on the redistribution of shear forces in the shear connection and shear force-slip displacement relationship was explicitly investigated. Depending on those factors, a simplified formulation was proposed to determine the configuration of the anchorage zone for practical application.

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How Concrete can help Local Authorities to protect communities

Mr Ralf Kessel[1]
[1]Concrete NZ, Wellington, New Zealand

Session 4, Auditorium, November 14, 2024, 3:30 PM - 4:45 PM

Concrete is a preferred material for infrastructure and buildings due to its durability and strength. It can withstand various hazards and stresses, making it an ideal choice for building climate-resilient communities. Concrete is also a low carbon material with emissions ever decreasing. The cement and concrete industry has committed to producing net-zero concrete by 2050 to eliminate its impact on the global climate. This is an important step in mitigating climate change, which is the most significant challenge we face today.
Society’s infrastructure must be resilient to withstand the effects of climate change.
One of the key factors that contributes to resilience is the choice of materials for infrastructure and buildings. The materials we use to construct our cities and towns have a significant impact on how they perform and respond to various hazards and stresses. Among the many materials available, concrete stands out as a preferred option for resilience. Concrete is a manufactured material that mainly consists of cementitious material, water and aggregates, such as pebbles and sand. It has all the properties that make it suitable for resilience, such as strength, durability, fire resistance, sound attenuation, thermal mass, security, natural carbon sink and disaster resilience.
Concrete can protect our cities and communities due to its properties.
In this paper, the benefits of using concrete for and the role of concrete in resilience, as well as some best practices and recommendations for local Authorities on how to use concrete effectively and efficiently for resilience is outlined. Examples and case studies of concrete structures that have demonstrated resilience in different contexts or scenarios are provided. It is argued that concrete is a key material for resilience and that local Authorities should adopt concrete as a preferred material for their infrastructure projects.

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Avoiding Problems in Concrete Construction

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Many current construction staff do not have a wide knowledge of potential problems and defects in concrete construction. This paper will cover potential problems and defects and how to avoid them including:

- Mix design—the importance of considering the components of the concrete mix including aggregate size, cement content, and admixtures.
- Cover—ensuring the specified cover is critical for durability of the concrete structure. This is often overlooked, and formwork design needs to ensure cover can be checked.
- Cover is absolutely critical for concrete used in marine exposure zones. (see photos).
- Placing techniques including checking the slump of the concrete, vibration and ensuring formwork is adequate for the project.
- Curing of concrete. This is often overlooked and results in cracking of concrete especially thin toppings. The agreed curing method needs to be agreed and arranged before the concrete is poured. I have witnessed a thin concrete topping cracking within hours on a windy hot day in Wellington.
- Avoiding collapse during construction—examples discussed will include launched bridges at Ngauranga and Injaka South Africa. Also the Miami Bridge collapse in Florida USA will be discussed.
- Avoiding collapse of a structure due to inadequate maintenance. The example chosen will be the Morandi Bridge collapse in Genoa Italy where the toll company (Benneton) was responsible for the bridge maintenance. Benneton is well known as a handbag manufacturer. Maintenance of any structure is important and includes monitoring all parts of the structure. For a bridge the bearings and expansion joints often need replacing part way through the design life cycle of the structure.