concrete

VOLUME 58 ISSUE 3/4

READING CONCRETE CAN CONTRIBUTE TO YOUR SKILLS MAINTENANCE

ArchEng IV Student Workshop

DESIGN CHALLENGE BECOMES MATERIAL NEUTRAL UNDER BRANZ

International Concrete Stories

CONCRETE ROADS IN AUSTRALIA AND UK HIGH-RISE CONCRETE CONSTRUCTION

2015 Concrete³ Sustainability Awards

EXCELLENCE IN SUSTAINABLE CONCRETE CONSTRUCTION RECOGNISED

CCANZ
concrete answers

UPFRONT

Industry awards have become *de rigueur* over recent decades as a way to recognize and honour individuals who, or companies that, have made a significant contribution to their field of endeavour.

And rightly so, as awards offer an opportunity to raise profile and make people feel that their work is valued, while the presentation ceremony itself is a chance for celebration and reflection. Recognition also helps motivate people.

Across a two-year timeframe the wider concrete industry celebrates its own success in terms of ready mixed concrete, finishing and placing, engineering and architectural feats, as well as its contribution to a sustainable built environment.

In doing so we shine the light on a wide range of professionals, including concrete technicians, mix designers, operational staff and placers, as well as builders, architects and engineers.

Yet there is one group we have tended to neglect in terms of recognition – namely our people in training.

Although we place a premium on knowledge and experience, and recognise the value of existing expertise, we also realise that our workforce is ageing.

There is a strong argument for training based on the proposition that human capability is both a key asset and a critical risk for firms across the spectrum.

A priority for the wider concrete industry is therefore to train well and train appropriately in order to secure strong future prospects.

Trainees need not necessarily be young people, but rather those who have a desire to expand their skill set and become qualified professionals.

Having said that however, it is important to understand 'Generation Y' (15-35 year olds) as they will make up a significant proportion of the workforce by 2025.

Young workers need a reason to stay which is greater than that to leave. Apprenticeships and mentoring can help greatly in this regard.

While our industry is busy promoting the importance of training, we should take time to acknowledge the effort of current apprentices as well as the support offered by their employers.

To this end, CCANZ in association with the Building and Construction Industry Training Organisation (BCITO), has recently announced that the inaugural Concrete Apprentice of the Year Award will be presented at the October 2016 New Zealand Concrete Conference in Auckland.

The Award will be open to all trainees enrolled in Level 3 and 4 BCITIO concrete qualifications.

As the hard skills across these qualifications are reasonably distinct, wider personal attributes will also be considered as a set of criteria.

The supportive employer of the winning trainee will similarly be acknowledged, and share in the triumph.

CCANZ looks forward to working with the BCITO over the coming months to identify the "best-of-the-best" in terms of concrete industry trainees, and sharing their success at next year's Conference in the form of the Concrete Apprentice of the Year Award.

Rob Gaimster
CCANZ, CEO

concrete
MAGAZINE

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Cover image: Carlaw Student Village, Auckland.

LBP SKILLS MAINTENANCE UNDERGOES CHANGES

The Ministry of Business, Innovation and Employment (MBIE) recently announced that the current requirements for the Licensed Building Practitioner (LBP) Skills Maintenance scheme have changed.

The changes came into effect on 2nd November 2015 when LBPs started a gradual transition to the new Skills Maintenance scheme.

The new system moves away from an entirely points-based system towards a new 'mixed-model' approach. The aim is to promote a more meaningful and relevant learning for LBPs.

COMPULSORY ACTIVITIES

Codewords/LBP Knowledge
LBPs will be required to read Codewords/LBP Knowledge articles and complete a short quiz. The articles will cover changes to the law and technology LBPs need to be aware of.

On-The-Job Learning
On-the-job learning activity is an easy way of recording information on how you continue to learn in your area of practice.

Over the 2 year timeframe simply select at least two project examples where you've had to learn something new or you've had to complete a more complex job.

The evidence for your examples could be a copy of a Record of Work (RoW) form or a Certificate of Work (CoW) form, or any documents recording what you have done and what you have learned on the job.

ELECTIVE ACTIVITIES

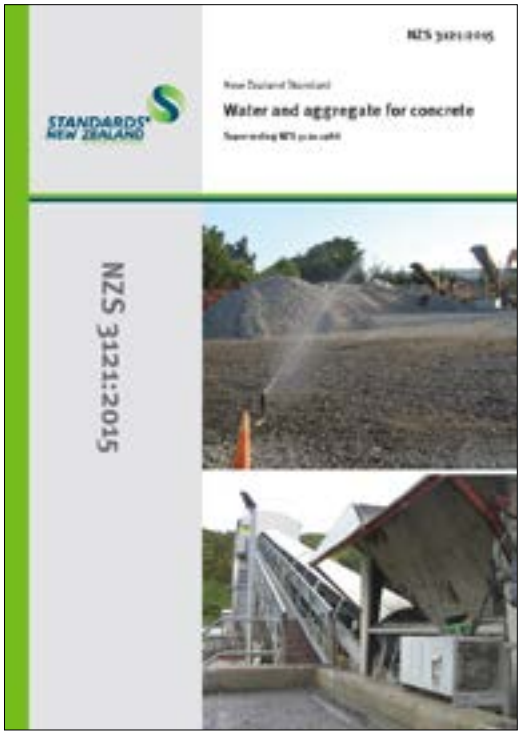
LBPs will need to do relevant elective activities the same way they do now where 1 hour = 1 LBP point. The minimum number of points has been reduced to:

LICENCE CLASS	NUMBER OF POINTS
Bricklaying & Blocklaying, Carpentry, External Plastering, Foundations and Roofing	12
Design or Site area of practice 1	15
Design or Site area of practice 2 & 3	18

Find more information about the new scheme at www.lbp.govt.nz.

REVISED STANDARD FOR WATER AND AGGREGATE FOR CONCRETE

NZS 3121:2015 WATER AND AGGREGATE FOR CONCRETE HAS RECENTLY BEEN PUBLISHED AND REPLACES A DATED 30 YEAR OLD STANDARD.



During that time much has changed in terms of the natural materials used to manufacture concrete.

The Resource Management Act has also placed restrictions around the manufacture of concrete. Practices of yesteryear, particularly in respect of dumping highly alkaline waste concrete, carry heavy penalties today.

This has resulted in the routine recycling of wash-water for use as mix-water. To avoid affecting setting times, the fines content of agitated wash-water needs to be monitored and restricted to an upper limit of SG of 1.07 by diluting with wash-water.

Close liaison between the ready mixed concrete plant engineer and the aggregate supplier is implicit throughout the Standard.

The Standard covers three new areas:

- The identification of alkali aggregate reactivity with reference to CCANZ *TR 3 Alkali Silica Reaction Minimising the Risk of Damage to Concrete Guidance Notes and Recommended Practice*. If an aggregate is potentially reactive, the aggregate producer shall declare this to the concrete producer. The most common source of reactive aggregates is from the volcanic plateau in the North Island.
- The chloride content of aggregate is to be tested by the aggregate producer at a frequency agreed to meet limits set by the concrete producer. These chloride limits are based on the maximum limits for concrete in *NZS 3109 Concrete Construction* and *NZS 3101 Concrete Structures Standard*.
- The use of recycled coarse aggregate with reference to CCANZ *TR 14 Best Practice Guide for the Use of Recycled Aggregates in New Concrete*. Recycled aggregate may contain undesirable constituents requiring more frequent testing. Recycled aggregate from fresh concrete of known constituents with known properties is preferable to the use of recycled demolition concrete. The Standard gives a list of recycled aggregate reportable properties which may be requested by the plant engineer.

Thirty years ago the use of natural rounded river-run aggregate and sand was common in ready mixed concrete operations. Depleting natural resources and environmental restrictions mean that crushed aggregate and sand are used in most concrete plants today.

Grading tests, monitoring the variability over time of aggregate and sand remain as compulsory tests.

However, with the greater reliance on quarried aggregates, and the risks associated with the increased use of marginal aggregates, establishing and controlling cleanness of sand, particularly clay content, is important.

Different aggregates will require different assessment methodologies and consequently control limits. In addition to mandatory control testing meeting standard limits, the plant engineer may choose a minimum number of additional tests with site specific control criteria in conjunction with the aggregate supplier.

For coarse aggregate, Australian tests for wet and dry strength variation and weak particles in coarse aggregate have been introduced and typical compliant values are given.

For quality of fines tests, the extent to which detrimental fine dust or clay like material may be present in the final sand can be determined by choosing from the following tests:

- Sand Equivalent
- Clay and Silt Content
- Weighted Clay Index
- Clay Index
- Petro-Graphic Analysis

The 'full revision' of NZS 3121 was made possible by the New Zealand Ready Mixed Concrete Association (NZRMCA), with assistance from the Aggregate and Quarry Association of New Zealand (AQA) and Standards New Zealand.

To purchase a copy of NZS 3121:2015 Water and Aggregate for Concrete visit the Standards NZ website - www.standards.co.nz

NZRMCA PLANT AUDIT SCHEME SUPREME AWARD

Presented at the Concrete Conference in Rotorua, the 2015 New Zealand Ready Mixed Concrete Association (NZRMCA) Plant Audit Scheme Supreme Award went to Allied Concrete's Nelson plant.

The Award acknowledges consistently high performance over an extended period of time. The 2015 winner was selected from a group of plants that had received Excellence Awards in at least four of the last five years.

NZRMCA Honorary Life Member Fred Thomas helped present the Award.

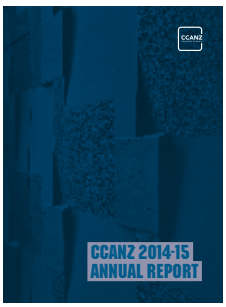
Allied Concrete's Blair Olynsma and NZRMCA Honorary Life member Fred Thomas

CCANZ ANNUAL REPORT

The 2014-15 CCANZ Annual Report was presented at the 2015 Annual General Meeting held recently at the Concrete Conference in Rotorua.

Reporting against the strategic plan, the document outlines achievements within the areas - Baseline Activity, Communications, and Projects - the latter grouped into the following themes:

- Strategic Initiatives
  - Association Consolidation
  - Infrastructure
  - Multi-Unit Housing Segment
- Business As Usual Initiatives
  - Residential Flooring Market
  - Commercial Market
  - Skills Priorities
  - Research Priorities
- Assorted Projects
  - Review of Communication Tools
  - Training Courses & Standards Development



The fulfilment of the CCANZ work programme during the 2014-15 took place against a healthy construction backdrop that saw industry interests advanced in terms of Standards development and the provision of training in particular.

The 2014-15 CCANZ Annual Report can be downloaded from the CCANZ website - www.ccanz.org.nz.

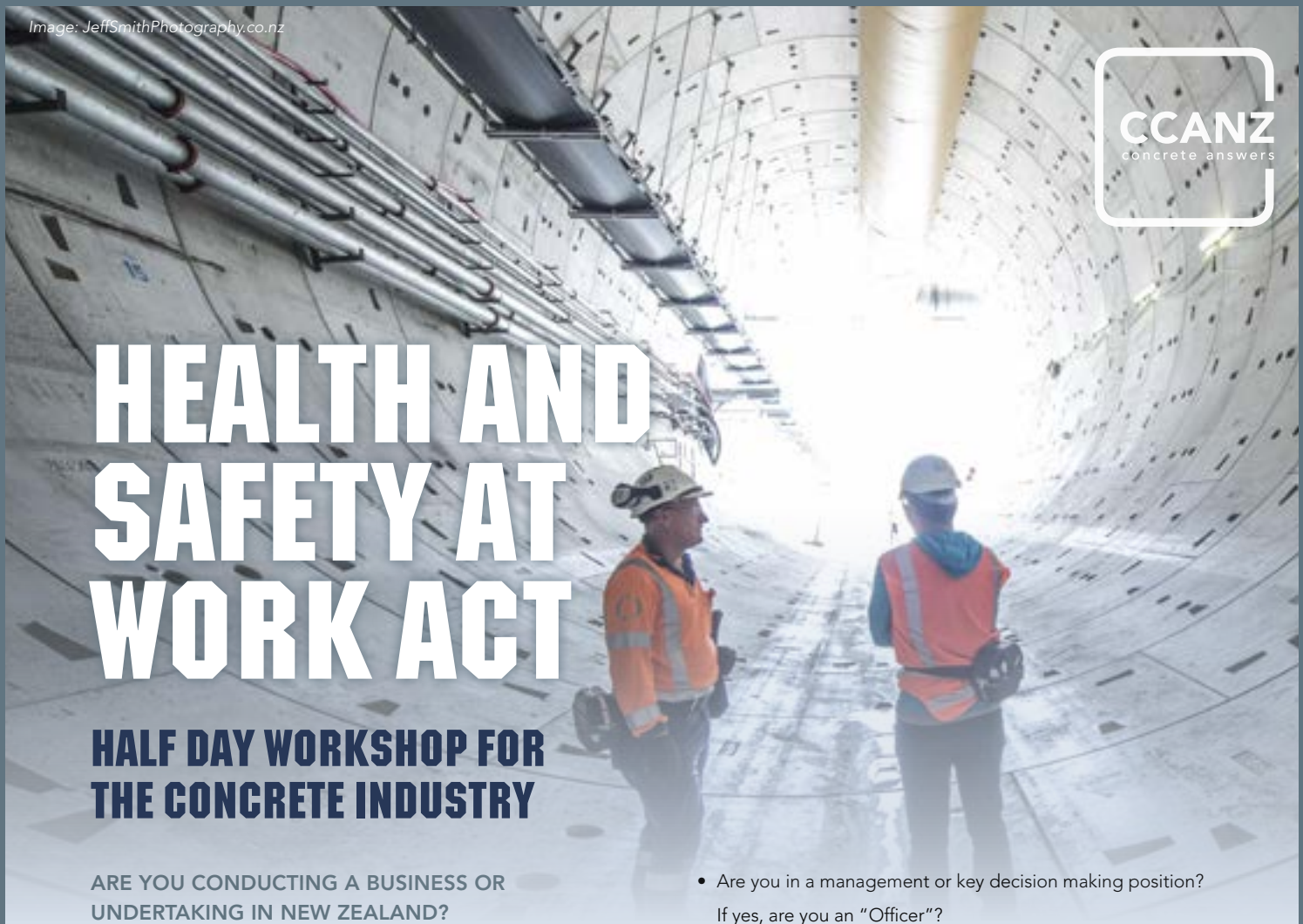


Image: JeffSmithPhotography.co.nz

HEALTH AND SAFETY AT WORK ACT

HALF DAY WORKSHOP FOR THE CONCRETE INDUSTRY

ARE YOU CONDUCTING A BUSINESS OR UNDERTAKING IN NEW ZEALAND? WHAT DO YOU NEED TO KNOW? WHAT DO YOU NEED TO DO?

The Health and Safety at Work Act will come into force on 4 April 2016. Are you ready for it?

CCANZ is planning a half-day workshop on the new Health and Safety at Work Act in Auckland, Wellington and Christchurch throughout February 2016. At this workshop you will be provided with practical and informative advice on:

- The new health and safety laws and what they mean: this will include discussing the duties of persons conducting a business or undertaking, and officers of companies
- The key obligations of employers as a result of the proposed Worker Participation Regulations
- What to do if there is a serious accident at work
- What to do if WorkSafe come knocking on your door
- What you should do next: are your policies and practices up to date

OUTLINE FOR WORKSHOP

- Are you conducting a business or undertaking in New Zealand?

  If yes, what specific duties apply to you as a "Person Conducting a Business or Undertaking" (PCBU)?
  - What are your duties?
  - Do you manage and control the workplace?
  - How should multiple PCBUs work together?
  - Overlapping duties on a large construction site
  - Duties of the head contractor and subcontractors
- Are you in a management or key decision making position?

  If yes, are you an "Officer"?
  - Who falls within the definition of an "Officer"?
  - What duties apply to Officers?
  - What does "due diligence" mean?
- Engagement, Worker Participation and Representation
  - What does "Engagement" and "Worker Participation" mean?
  - Do you need to have a health and safety representative?
  - What are health and safety committees?
  - What is a work group?
- Volunteers
  - When is a volunteer a "volunteer worker"?
- Enforcement measures and processes
- Where to next?
  - How to assess your risk
  - What documents should you review
  - We will consider a case scenario relevant to your industry

Registration fee $325 +GST.

WHO SHOULD ATTEND

The workshop will be targeted at all sectors in the wider concrete industry, including placing and finishing, sawing and drilling, ready mixed concrete production and precast concrete manufacture.

INTERESTED IN ATTENDING?

If you would like to attend please convey your expression of interest and preferred location (Auckland, Wellington or Christchurch) to:

Angelique Van Schaik on 04 499 8820 or admin@ccanz.org.nz by 18 December 2015.

Once the level of interest has been determined you will be notified of the February 2016 date for your preferred location.

Hon. Jo Goodhew, Associate Minister for Primary Industries, with Ashley Jones and Simon Gourley.

ARCHENG IV - STUDENT WORKSHOP FOSTERS COLLABORATION FOR FUTURE OUTCOMES

The annual ArchEng (architecture/engineer) three day student workshop continues to go from strength to strength, with the 2015 edition held recently in Wellington at the Victoria University School of Architecture.

A Cement & Concrete Association of New Zealand (CCANZ) initiative that began in 2011, the workshop expanded this year to also involve the timber and steel industries.

Sponsored by BRANZ, the genesis of ArchEng hinged on the phrase "good design is good engineering". It brings together the best students from New Zealand's final year Architecture and Engineering schools to experience the value of cross disciplinary collaboration. The students work in partnerships on a design challenge over three days. A cash prize of $5,000 is awarded by a judging panel for the winning result.

Twenty two students participated in this year's event, which was hosted by Victoria University. Responding to a simple brief to design 'an iconic waterfront project', inspiration came from the keynote speech by Sean McGuiness, of construction company LT McGuiness, in which he outlined the construction challenges associated with the Clyde Quay Wharf development.

A subsequent site visit was conducted by the project designers, Martijn van der Tol of Athfield Architects and structural engineer Ryan Clarke of Dunning Thornton. Martijn and Ryan impressed upon the students that a successful project is founded on effective collaboration.

CCANZ Chief Executive Rob Gaimster is proud the concrete sector conceived the initial concept. "In 2011 we identified an opportunity to encourage aspiring construction specialists to work together to incorporate the best insights and latest technology into a building design," says Rob. "Over the following three years CCANZ grew the workshop to strengthen the bonds between future architects and engineers in the belief that the better they work together today the better the built environment outcomes will be tomorrow."

"It was a natural progression to hand over the reins to BRANZ, who had supported the event for a number of years, and for them to take the 2015 event to the next level with a neutral use of construction materials," adds Rob. "As with previous years the students responded to the challenging but rewarding experience; developing their skills, creating a professional network and enjoying themselves at the same time."

The 2015 prize-winners were Simon Gourley (Architecture, Victoria University) and Ashley Jones (Engineering, University of Auckland), who created *The Outcrop*, a movable floating walkway designed to extend 150 metres into the Wellington harbour.

The Hon. Jo Goodhew, Associate Minister for Primary Industries, hosted this year's prize giving at Parliament House on July 10th. Along with BRANZ and CCANZ, other associations represented at the event included IPENZ, NZ Institute of Architects (NZIA), Heavy Engineering Research Association (HERA), the NZ Timber Design Society (NZTDS), the Wood Processors and Manufacturers Association of NZ (WPMA), and Engineered Wood Products Association of Australasia (EWPAA).

BRANZ





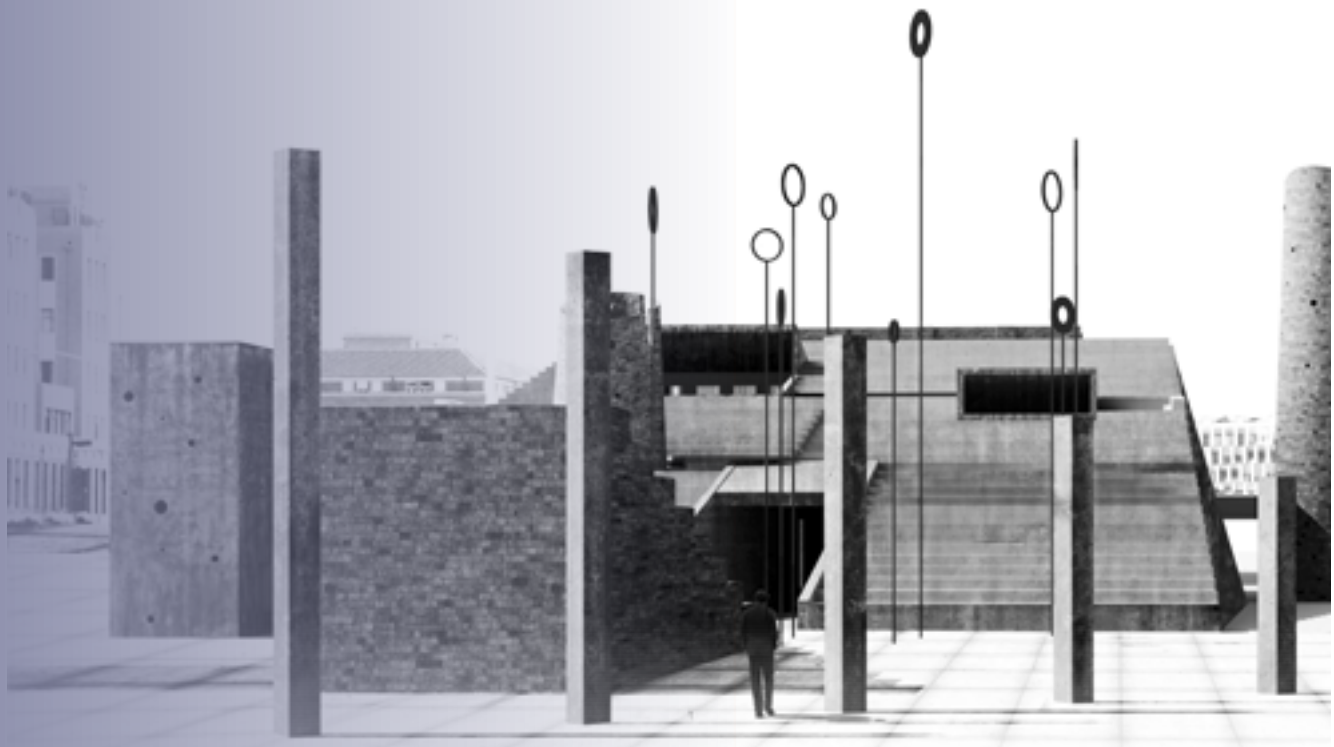




DESIGN PROPOSALS NATIONAL EARTHQUAKE MUSEUM

CCANZ ARCHITECT (DEU) RALF KESSEL WAS RECENTLY ASKED TO AGAIN HELP REVIEW THE DESIGN PROPOSALS SUBMITTED BY ARCHITECTURE STUDENTS AT VICTORIA UNIVERSITY OF WELLINGTON'S SCHOOL OF ARCHITECTURE.

Under the direction of Andrew Charleson (Associate Professor – Architecture) the 3rd year students were faced with a brief to conceive a National Earthquake Museum on a prominent Wellington waterfront site. Using concrete as the primary construction material the museum was to offer a range of functional spaces, and also symbolise the immense power of earthquakes in shaping lives and landscapes. The following pages showcase a small selection of the many outstanding designs presented by the students.

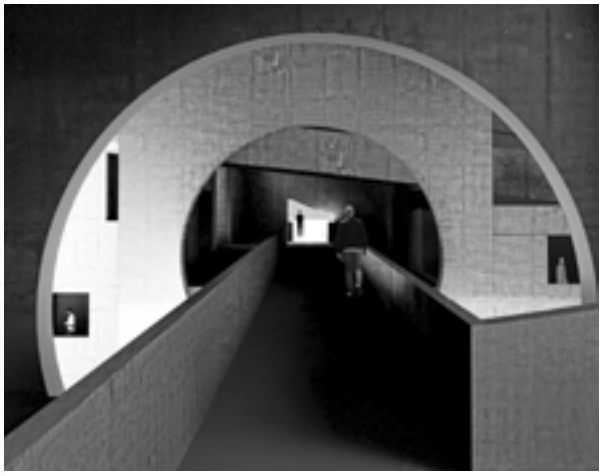


BRENT RANE (LEFT & ABOVE)

Utilising a generic rectangular plan this design for an Earthquake Museum warps and deforms the structure to denote the collision of tectonic plates. The new concrete form is structurally reinforced to provide a code compliant building, although the intended atmosphere of implied danger is still apparent.

JESSE EWART (ABOVE & BELOW)

The emphasis here was to design a museum that has the capacity to convey the dynamic scale and movement of earthquakes in a static form. The Silo vaults act as a memorial of events surrounding New Zealand earthquakes. Monumental in form these vaults reflect a water edge typology of port silos, each representing a collective storage of memories.



FLORENCE DE LISLE (LEFT)

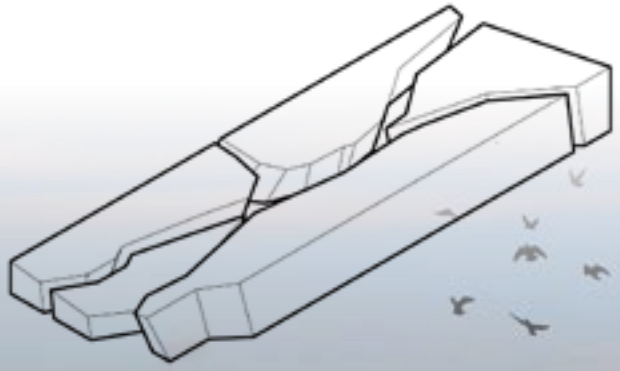
The focus of this design is respect for nature and its unpredictable power. The spine of the museum looms over the interior spaces and those who occupy them, becoming more prominent in the memorial space. The dramatic lean of the concrete slabs represents the scale difference between humans and the natural environment, as well as implying that we are always subject to a volatile force.

LUKE PETTERSON (ABOVE)

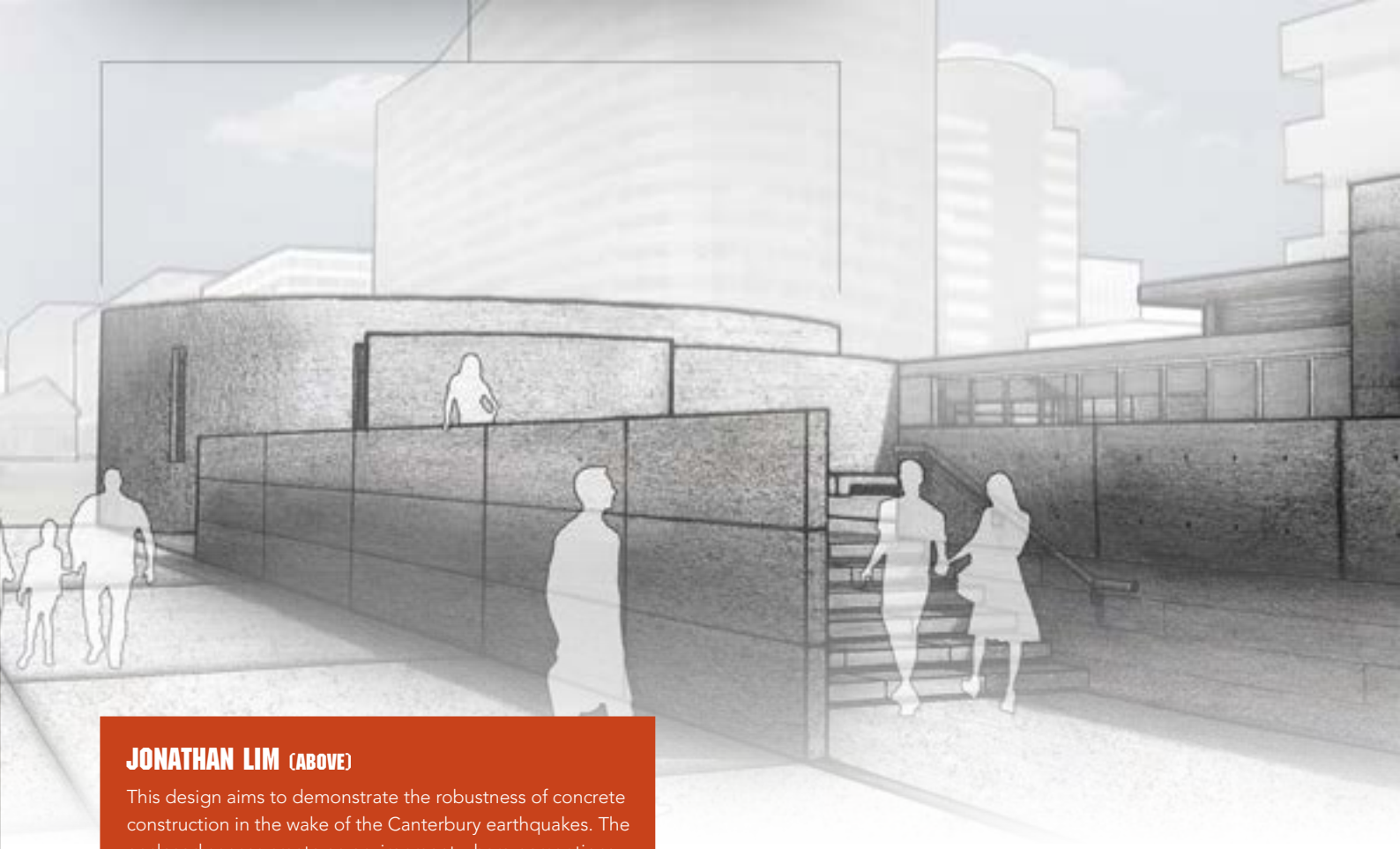
The concept driving this design is an emphasis on disposition. Where entities in an earthquake are displaced from their original position, non-uniform structural elements emerge resulting in habitable volumes. Precast concrete moment frames enhance the design through an inconsistent arrangement.

DIVYESH BHAVEN (BELOW & RIGHT)

Here inspiration is derived from the fracture of the land. Tectonic plates collide resulting in the upheaval of the Earth's surface to reveal the mantle - represented by an illuminated water feature. The beams of light directed towards the sky denote the souls of those who have perished in earthquakes.



BUILDING FORM



JONATHAN LIM (ABOVE)

This design aims to demonstrate the robustness of concrete construction in the wake of the Canterbury earthquakes. The enclosed spaces create an environment where perceptions of concrete and a sense of safety are explored through experimentation of light, shadow, openness, and form.

THE TEAM AT A1 – GOING THE EXTRA MILE

THE TEAM AT A1 KIWI CUTTERS & DRILLERS IN AUCKLAND IS QUITE UNIQUE WITHIN THE CONCRETE INDUSTRY. THEY'VE BEEN IN BUSINESS FOR 10 YEARS UNDERTAKING RESIDENTIAL AND COMMERCIAL PROJECTS – RANGING FROM SMALL RESIDENTIAL CUTTING TO BIG PROJECTS SUCH AS ST LUKES BRIDGE REMOVAL AND THE SUGARTREE APARTMENTS.

BCITO buildingpeople

The whole crew at A1 Kiwi Cutters & Drillers Ltd

(left to right) Penny Simons & Janine Douglas, Directors, A1 Kiwi Cutters & Drillers Ltd

Penny Simons and Janine Douglas, who run the business together, believe their uniqueness is that the company is effectively run by the two women who take the calls and book and distribute the jobs. The big difference though is that these two also know how to use the tools themselves!

Penny and Janine were both trained by Mark Simons, the other company director. Mark is Penny's husband and he's been concrete cutting for 33 years across England and New Zealand.

Another trait that makes them special is their commitment to enhancing the skill levels of their staff.

A1 Kiwi Cutters & Drillers are avid supporters of industry training and hope to be one of the first cutting and drilling firms in New Zealand where all employees have completed a nationally recognised concrete qualification.

The business considers itself to be leaders in the culture of training, placing a huge emphasis on supporting their staff to become qualified. They are also pleased when they see other businesses get on board with industry training.

"When the cutter/driller is recognised as a qualified person, they become more confident in their work and also feel respected within the company," says Penny. "Customers these days are savvy and want to know what qualifications your staff have. It's easier to sell your services when you can prove your people are qualified to nationally recognised standards. It's one of the best selling points we have."

"A lot of concrete cutters aren't even aware that qualifications for their specific trade are available. We want to help get the word out so that our industry is seen as a real profession," Janine adds. "We feel really good about training our staff – it provides the individual with much more opportunities for their future career, as well as being good for our business."

"We train our people and our BCITO Training Advisor comes to visit regularly to make sure every apprentice is on track. He's a good communicator and has a thorough understanding of our trade," says Penny.

Within the business Penny and Janine have helped between 8 and 12 apprentices become qualified in cutting and drilling, and currently have five who are part way through their training. "Training our staff with BCITO helps grow our business. New employees are eager to come on board with us when they find out they're going to get a qualification, as well as getting paid to come to work each day," says Janine.

"It may also be that, in the near future, certain customers will only allow companies who have qualified staff to work on their site. That's when we'll reap additional benefit from investing in training now. We're future-proofing our business through industry training."

Contact BCITO on 0800 422 486 to find out more about qualifications for Concrete Cutting & Drilling.

Images: David Higgins Photography

EA NETWORKS CENTRE WINS 2015 SUPREME CONCRETE³ SUSTAINABILITY AWARD

WARREN AND MAHONEY ARCHITECTS HAS TAKEN HOME THE 2015 SUPREME CONCRETE³ SUSTAINABILITY AWARD FOR THE EA NETWORKS CENTRE IN ASHBURTON, A MULTI-PURPOSE INDOOR SPORTS AND AQUATICS COMPLEX THAT REFLECTS THE REGION'S COMMITMENT TO LEISURE AND COMMUNITY FACILITIES.

Alex Head, Associate with Warren and Mahoney Architects, receives the 2015 Supreme Concrete³ Sustainability Award

The Award, presented at the annual New Zealand Concrete Conference in Rotorua on Friday 09 October, celebrated concrete's role in realising the Centre's simple concept of a single linear space - housing stadium at one end and aquatic facilities at the other - to provide a cost-effective and resilient solution, says Cement & Concrete Association (CCANZ) chief executive Rob Gaimster.

The judging panel applauded Warren and Mahoney Architects' use of concrete to achieve durable permanence, thermal efficiency, an attractive aesthetic as well as space flexibility in this large community facility that serves the wider Mid Canterbury region.

The judges acknowledged the use of locally sourced greywacke aggregate by Ashburton based precast concrete company McIntosh Precast to ensure the building considered social sustainability values, as well as addressing environmentally sustainable design principles.

Concrete's thermal mass is exposed in the entrance foyer as part of an overall passive solar thermal strategy, which also utilises insulated concrete wall panels in the front of house area to help moderate temperature variations.

Concrete panels and columns continue through the swimming pool hall to reduce maintenance, while the braided river design cast into the concrete exterior echoes the surrounding landscape to stunning effect.

The EA Networks Centre is no doubt already a much treasured addition to Ashburton's built environment, one that proudly embodies the principles of sustainable concrete construction.

On its way to the top prize, the Warren and Mahoney team also won the **Excellence in Concrete for the Community** category award. Concrete Plus Ltd received a Merit Award in this category for the Pembroke Skate Park extension in Wanaka.

The Awards are part of the Concrete³ initiative launched in 2007 by CCANZ, and acknowledge projects, products and initiatives which demonstrate excellence in environmental, economic and/or social sustainability for the built environment.

Concrete^3

OTHER CATEGORY WINNERS

THE AWARDS ALSO PRODUCED WINNERS IN FOUR OTHER CATEGORIES FOR PROJECTS WHICH EXCELLED IN DIFFERENT AREAS OF SUSTAINABLE CONCRETE CONSTRUCTION.

EXCELLENCE IN RESIDENTIAL CONCRETE CONSTRUCTION - STUDIO PACIFIC ARCHITECTURE FOR RAWHITI SLEEPOUT IN THE BAY OF ISLANDS

Rawhiti Sleepout set out to incorporate the client's functional brief, the site's existing culture and key considerations of longevity, visual sensitivity and environmental responsiveness. The use of concrete was a key aspect in achieving these aspirations.

Constructing sensitively within an 'outstanding landscape' was critical in the decision to build a new and separate building away from the existing bach, nicknamed the Sleepout. The design of the Sleepout takes its lead from the site's geographical qualities and hunkers down into the hillside, minimising the visual impact and providing bedrooms that offer a retreat from the communal bustle of the main building.

The majority of the building is made of concrete; the floor, retaining walls, perimeter walls, fin columns, and the roof. The strength of the concrete structure allows the roof to support an intensive green roof as an extension of the hillside. The combined mass of concrete, hill and green roof establishes a stable internal environment that can be further manipulated by the occupants.

The Sleepout uses concrete as its primary material, reinforcing a sense of gravitas and permanence, while also allowing the design to achieve an overall sculptural response to the site. Natural textures, colour and grain are carefully manipulated in the concrete surface to create a resonance with the surrounding natural environment. The contractor's craft during construction has achieved a sense of luxury, warmth and intimacy in the interiors.

65% Ground Blast Furnace Slag cement substitution (Holcim Duracem) in the roof slab helped off-set CO_2 emissions, as well as increase durability and weathertightness.

EXCELLENCE IN CONCRETE INNOVATION - ALLIED CONCRETE FOR ITS EPD FOR READY MIXED CONCRETE USING HOLCIM (NZ) LTD MANUFACTURED CEMENT

Allied Concrete applied for an Environmental Product Declaration (or EPD) in 2014 based on analysis of its 2013 production. Using Life Cycle Assessment tools courtesy of Holcim New Zealand's membership of the World Business Council for Sustainable Development, a huge data collection process was undertaken across energy and material inputs for a range of concrete strengths.

The system boundary declared in the EPD includes raw material supply, transport and manufacturing up to the batching plant gate. This covered:

- Cement manufacturing
- Admixture production & delivery
- Cement distribution by sea & land transport
- Water consumption
- Aggregate production
- Waste volumes generated & associated disposal costs
- Aggregate delivery to the plants
- Energy use at the plants (electrical, fossil fuel)

The declared unit is 1 cubic metre of pump and standard grade concrete from 17.5 to 50 MPa produced in accordance to *NZS 3104 Specification for Concrete Production*. The data collection process took 10 months to complete, with BRANZ managing document preparation and Studio Fieschi & Soci of Italy as EPD verifier.

The completion of possibly the first EPD in Australasia for ready mixed concrete has enabled Allied Concrete to benchmark its environmental performance and examine potential efficiencies.

Concrete[3]

EXCELLENCE IN COMMERCIAL CONCRETE CONSTRUCTION - NAUHRIA PRECAST FOR CARLAW PARK STUDENT VILLAGE

Part of the Carlaw Park master plan, the new Carlaw Park Student Accommodation Campus, Stage 1, for the University of Auckland, helps refresh a forgotten area of Auckland. Critical to the revitalisation were sustainable design principles.

The campus consists of self-contained apartments with communal lounges, study spaces and amenities for all students. Four building blocks are carefully orientated to maximise city and park views, and shrouds a central outdoor plaza for student gatherings.

Each building was modulated by breaking it into three 'blocks' with the two end blocks being finished with monolithic and textured Monarc precast concrete. The contrasting facades create interest and variance, helping to reduce the bulk and mass of the site.

The new campus buildings are orientated with the main mass facing against the northern and eastern boundaries following the natural land form and capturing the sun's heat. High levels of wall and roof insulation combine with concrete's thermal mass to minimise temperature fluctuations.

Studies were undertaken of internal noise control requirements, with acoustic controls being applied to all inter-tenancy walls as well as floors and ceilings to provide a better living environment for the tenants.

The use of concrete provided considerable efficiency in construction, spectacular architectural appeal, and excellent thermal benefits, while also enabling a low maintenance schedule that allows the buildings to age gracefully, with minimal on-going costs.

EXCELLENCE IN CIVIL CONCRETE CONSTRUCTION - WILCO PRECAST FOR THE ECORETAINER™

End of life tyres have been identified as a major environmental problem in New Zealand with some 85% of the 6,000,000-plus waste tyres generated annually (62,000 tonnes) being sent to landfill. EcoRetainer Ltd, in conjunction with Wilco Precast Ltd, has developed an interlocking precast concrete block with a bale of compressed tyres encased within the concrete.

The 4-4.5 tonne blocks, which have a New Zealand patent, are designed with dimples and locating channels to interlock at varying angles to form retaining walls, stop banks, sea walls and a variety of other infrastructural forms. EcoRetainer™ walls have applications anywhere there is a need for rapid, cost effective deployment of civil engineering solutions, including rock-fall protection structures.

EcoRetainer™ walls can be installed without specialist equipment or major site works and will save significant time and money when deployed. The structures can be left in-situ for years, or they can just as easily be removed and put into service somewhere else. Encasing tyres in concrete eliminates the possibility of leachates escaping into waterways. Comparative cost analysis has shown that for large retaining projects EcoRetainer™ walls are half the cost of other systems.

Further waste minimisation can occur through using recycled concrete to replace aggregate used in the mix. While recycling of concrete is not unique, the use of waste tyres combined with recycled concrete is. EcoRetainer™ is a good news story of Kiwi ingenuity developing a way to turn a source of troublesome and environmentally damaging waste into a useful product.

MULTI-UNIT BUILDINGS - CONCRETE COST AND PERFORMANCE BENEFITS

CCANZ RECENTLY UNDERTOOK A COSTING EXERCISE TO HELP BETTER UNDERSTAND WHICH CONSTRUCTION MATERIAL OFFERS THE OPTIMUM RETURN FOR MULTI-UNIT BUILDINGS IN TERMS OF UPFRONT COST, ON-GOING MAINTENANCE AND OVERALL PERFORMANCE.

CASE STUDY MODEL

The CCANZ study compared initial building costs, with concrete, steel and timber as the structural material, using a simplified apartment block model from the CCANZ entry in the 2012 *Breathe* competition for medium density mixed-use living in Christchurch.

The block consisted of three 4-storey units totalling:

- 2500 m^2 for apartments (21 one, two and three bedroom units)
- 825 m^2 for retail / office space

CASE STUDY - STRUCTURAL DESIGNS

Three different structural design options underwent analysis using the *Resist* software. For all three design options the following dimensions were consistent:

- 55 m — Building length
- 15 m — Building width
- 3.5 m — Overall storey height
- 14 m — Building height
- 205 mm — Ground floor concrete slab

The penthouse floor had lightweight walls and roof.

Three structural materials were applied to the design options:

1. Concrete — Bracing core, circular columns and timber infill (TI) span slabs
2. Steel — Eccentric framing and ComFlor slabs
3. Timber — Ply bracing walls, LVL columns, GL8 beams, struct. flooring

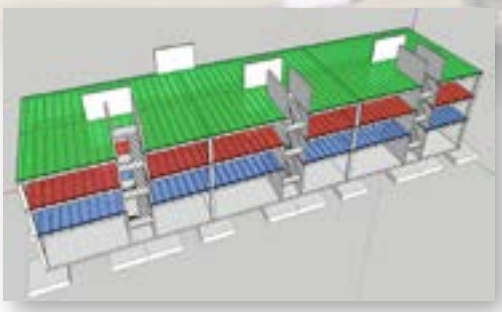
The design solutions were as follows:

CONCRETE

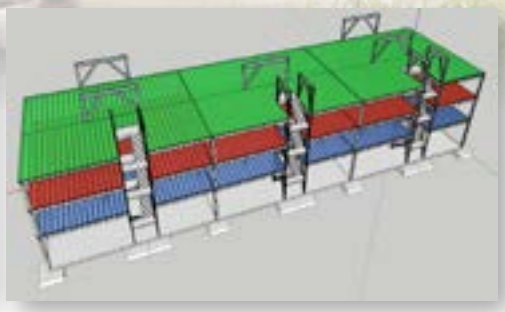
- Foundation — 33 pads of 3.9 x 3.9 m x 760 mm thick
- Columns — 450 mm square
- Floors — TI 250 concrete, 600 mm x 400 mm beams along 8.5 m span
- Bracing walls — 200 mm concrete, 10 of 5 m length
- External walls — Insulated concrete sandwich panels

STEEL

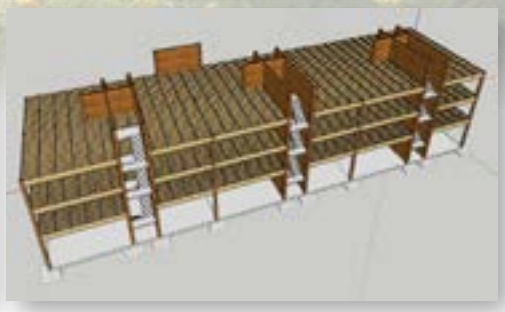
- Foundation — 35 pads of 2.4 x 2.4 m x 620 mm thick
- Columns — 250 UC 89
- Floors — ComFlor 210/90, 460 UB 67 beams along the 8.5 m span
- Bracing walls — Eccentric steel frames, 250 UC 89/ 360 UB 57, diagonals 360 UB 57+ 460 UB 67 beams towards the 8.5 m span
- External walls — Light frame, metal studs with insulation and weatherboards



CONCRETE



STEEL



TIMBER

TIMBER

- Foundation — 34 pads of 2.0 x 2.0 m x 330 mm thick
- Columns — 300 mm square, LVL
- Floors — GL8 540 x 90 by 1.7m, 250 x 50 by 400 mm, 30 mm GL structural flooring, GL8 630 x 90 beams towards 8.5 m span
- Bracing walls — 25 mm ply, 2 sides, 300 mm width, end columns 300 x 50 mm
- External walls — Light frame, timber studs with insulation and ply cladding

One noticeable difference between these design solutions is the foundation. The concrete solution required about three times the reinforced concrete compared to the steel solution and almost eight times compared to the the timber solution.

CASE STUDY - COST ESTIMATES

Cost estimates for the three material solutions were developed using the 2014 edition of the *Rawlinson Handbook*.

The largest upfront cost for the foundation element of the designs applied to the concrete solution, which demanded 380 m^3 of reinforced concrete at an estimated cost of $575,000. The steel solution's foundation was estimated to be $190,000, approximately 33% of the concrete solution. The timber solution was deemed to only require 45 m^3 of reinforced concrete, at an estimated cost of $70,000 - equivalent to 12% of the concrete solution.

However, the cost outlay is very different between the materials in relation to bracing. The ten concrete bracing walls of 200 mm structural concrete totalled $265,000, the steel solution's eccentric bracing frames were the most expensive at $475,000, while the timber bracing walls came in at $399,000.

The cost difference between the concrete and the timber bracing walls is not a result of the materials' price, but rather the quantities required. The ten 5 m long concrete walls provide sufficient bracing in themselves. Whereas for timber, four 6m long bracing walls are required along with six 10m long walls - an extra 24 m of bracing.

In addition, the cost of the timber bracing walls is driven up by the large 7.5 m and 8.5 m spans. Such wide spans require a stronger material in the form of Glulam or CLT beams, which come at a cost premium. More conventional and less expensive timber designs would span 5-6 m.

The study also estimated the timber flooring cost to be around twice that of the TI 250 concrete solution, while the steel ComFlor system (including beams) was 18% higher.

	Concrete	Steel	Timber
Foundations	100%	33%	12%
Columns	100%	146%	92%
Floor	100%	118%	192%
Bracing	100%	198%	149%
TOTAL	100%	103%	114%

Percentage summary of the total structural building costs based on the 2014 Rawlinson Handbook

MAINTENANCE AND PERCEPTION

Costs incurred following a building's completion for maintenance, operation and repair must be an important consideration during the project's initial decision making stages. This has traditionally not been the case, as upfront costs tend to be given greater weight by the developer over ongoing-costs.

Data collected from building surveyors in Auckland illustrates the maintenance costs of different cladding materials. Total maintenance costs over a period of 10 years:

- Concrete panels Annual inspection & wash down
  113 $/ m^2 100 %
- Weatherboards Annual inspection, wash down & 7 yr repaint
  160 $/ m^2 142 %
- Ply Wood Annual inspection, wash down & 7 yr repaint
  140 $/ m^2 124 %

These figures show that over decades the maintenance costs for a solid façade will be significantly less compared to lightweight cladding.

Anecdotally, building surveyors across Auckland anticipate that at least 70% percent of all existing apartment buildings have, or will experience, some form of "leaky building" issue.

In one particular high-profile case a 13 year old multi-storey development in Auckland was plagued by "leaky building" issues from day one. As a result, approximately 80 % of its timber structure has been replaced as its load bearing capacity was compromised.

FIRE AND SOUND REQUIREMENTS

Disruption from noise can be a serious threat to apartment inhabitants' health and well-being. The New Zealand Building Code (NZBC) *Clause G6 Airborne and Impact Sound* takes care to protect residents with the following requirements:

- Inter-tenancy walls shall provide at least STC 55 db sound attenuation.
- Inter-tenancy floors shall provide at least IIC 55 db sound attenuation.

As the move toward medium-density living gathers pace the importance of robust fire protection measures will also increase significantly.

The requirements for building performance in a fire are detailed in NZBC *Clause C Protection from Fire*. One mechanism for apartment design to comply with this Clause C is to follow the compliance document *C/AS2: Acceptable Solution for Buildings with Sleeping (Non-Institutional) (Risk Group SM)*. The fire rating required is 60 minutes for inter-tenancy partitions and floors, and for protection of escape routes.

FIRE AND SOUND - WALLS

The following wall *build ups* provide STC 55 db and F 60 fire ratings to comply with the NZBC:

- Concrete solution includes either a 150 mm in-situ or precast wall or a 200 mm solid filled masonry wall.
- Timber solution requires 100 x 50 mm double studs, or staggered studs, with 20 mm airspace in between, 100 mm sound insulation and two 10mm gypsum boards either side.
- Steel solution is very similar to the timber design just that timber studs are replaced by metal studs.

Cost proportions for ready installed 55 db sound walls with F 60 minutes fire protection:

- Concrete 150 mm 100 %
- Masonry 200 mm 94 %
- Double timber stud wall 90 %
- Double steel stud wall 85 %

Using the *Rawlinson Handbook* the metal stud solution works out less expensive than the timber equivalent, while both are slightly cheaper when compared to the two concrete solutions.

However, each material solution offers quite different levels of fire protection. While the steel and timber solutions are limited to F60 performance, the concrete walls provide inherent 180 minutes protection. This allows for greater guard against fire spread, as

well as more time for fire fighting personnel to enter the building, retrieve trapped occupants and conduct fire fighting activities.

To upgrade the timber or steel solutions to a 180 minutes of fire protection would require around 20% of their initial cost, which would render them more expensive than the concrete solutions.

Lightweight materials for internal walls do have advantages when allowing for easier space (re)configuration, as well as placing less load on the foundations. However, heavyweight alternatives usually perform better in terms of sound separation, fire performance and rot-resistance.

For instance, in the timber and steel *build ups* the linings would soften or dissolve with moisture ingress, resulting in compromised sound separation and fire performance. The studs and acoustic infill would most likely also be damaged, more so if the leak remained undetected for a period of time. Replacement would be the only (expensive) option.

Concrete walls also offer a higher degree of security compared to lightweight alternatives. This is particularly important as the population ages and the emphasis on community and personal safety increases.

FIRE AND SOUND - FLOORS

The following floor *build ups* provide IIC 55 db and F 60 fire ratings to comply with the NZBC:

- The concrete solution uses TI 250 mm slabs.
- The steel solution is a ComFlor 210/90 system.
  - Both solutions have underlay and carpet to separate the stepped on surface from the structure. This is required to avoid sound transmission and flanking via the floors and walls of the building.
- The timber solution requires GL8 540 x 90 mm beams each 1.7 m plus 250 x 50 mm joists every 400 mm. A 30 mm structural flooring is applied to the top.

To fire and sound proof the timber solution an additional substructure to carry the suspended fire / sound boards is required. The substructure must be separated from the main structure to avoid sound transmission and flanking via the floors and walls of the building. A sound insulation infill within the suspended part of the floor is also required to achieve the IIC 55 db rating (see also NZBC G6).

Estimated cost proportions for ready installed IIC 55 db sound and F 60 fire floors

- Concrete TI 250 mm 100 %
- ComFlor 210/90 118 %
- GL8 timber system[1] 192 %

1 *GL8 beams, joists, structural flooring, fire lining and separated impact sound protection.*

The TI concrete and the ComFlor systems are relatively competitive in regards to cost, durability, maintenance and long term sound and fire performance. However, the Glulam flooring is considerably more expensive.

Timber/ glulam flooring is less durable, particularly if moisture ingress occurs through leaks in the façade or at roof level. It is also at risk of being damaged from a small to moderate impact, while any penetration, for recessed lighting for instance, will compromise fire and sound ratings unless appropriately re-sealed.

It is mandatory to address fire and sound protection with floor designs but there are also differences in comfort and perception. Walking and living on a concrete floor provides a very solid and safe feel, while timber floors tend to be prone to shrinkage and eventually torsion, leading to creaking with pressure and changes in temperature.

MOVING FORWARD

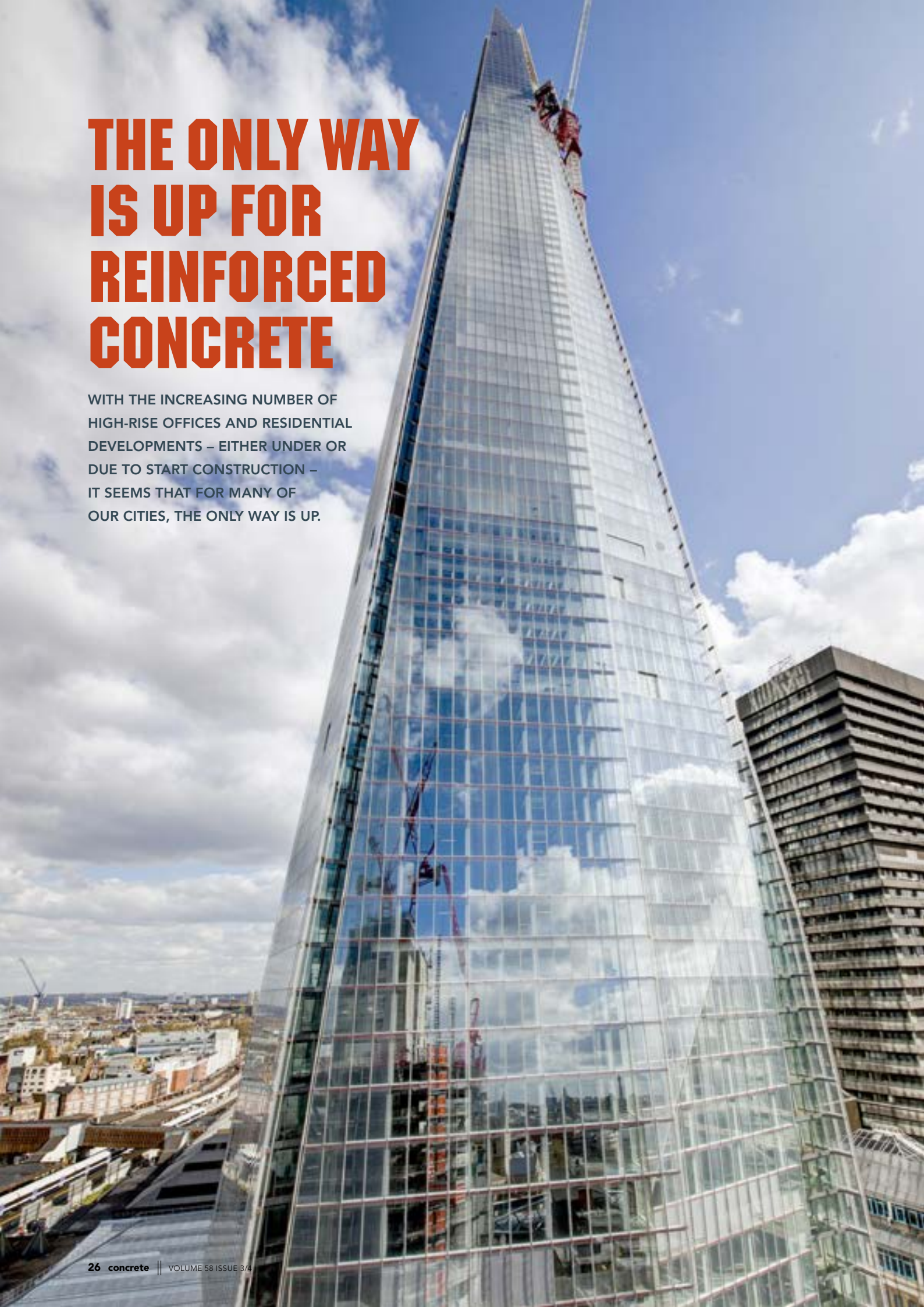
Driven by increased levels of immigration, a lack of available land and changing lifestyle choices our major cities are experiencing huge demand for multi-unit residential accommodation.

Cost (short and long term), along with performance must always be considered in combination for apartment buildings. Such an approach, as demonstrated by this study, sees a concrete solution offer a superior alternative over other materials.

Based on Kessel, Ralf. (2015) Multi-Unit Cost and Performance Study. Proceedings of the New Zealand Concrete Conference 2015. Rotorua, New Zealand.

THE ONLY WAY IS UP FOR REINFORCED CONCRETE

WITH THE INCREASING NUMBER OF HIGH-RISE OFFICES AND RESIDENTIAL DEVELOPMENTS – EITHER UNDER OR DUE TO START CONSTRUCTION – IT SEEMS THAT FOR MANY OF OUR CITIES, THE ONLY WAY IS UP.



The inherent benefits of reinforced concrete mean that it is particularly suited to fast and economic high-rise construction reports Stephen Elliott of the British Association of Reinforcement (BAR).

The choice of material for the structural frame of a high-rise building has a significant impact on its build time, cost and performance. Reinforced concrete has a range of inherent performance benefits, giving it a number of competitive advantages over other structural options.

CONSTRUCTION SCHEDULING

The old adage 'time is money' has never been more apt than when talking about construction programmes. Here, concrete – with a lead time of eight weeks, compared to 14 weeks for structural steel – has a distinct economic advantage. A faster start on-site means a faster total construction time and a quicker return on capital investment. The inherent performance benefits of reinforced concrete offer further time and cost savings. The material's built-in robustness and sound insulation minimises or even negates the need for additional finishes and its mass means that concrete floors generally meet vibration criteria without the need for extra stiffening. Concrete's mass also provides a high level of thermal efficiency – when used as part of a fabric energy storage (FES) approach it can reduce plant costs by reducing or removing the need for air conditioning.

FIRE RESISTANCE

A reinforced concrete structure offers a high level of fire resistance. A premium is incurred on steel frame for sealing and fire stopping at partition heads against the irregular soffits of the steel decking and around irregularly shaped intersecting frame members. Unless this is considered at the early design stage, it can result in expensive and time-consuming remedial work late in the construction programme. Staying with internal savings, mechanical and electrical services represent up to 34% of overall construction costs. The flat soffit of a concrete floor slab provides a clear zone, free of downstand beams. This allows more services to be prefabricated off-site and increases the simplification and ease of installation.

Additional savings can be made by the use of high-strength concretes and post-tensioned concrete floors. Studies have shown that the use of C50/60 strength class concrete can reduce the cross-section of vertical elements due to the provision of increased strength and stiffness. The same approach, when used for reducing slab thickness, can result in savings in other building elements – for instance, the area of the cladding and the internal partitions, thereby saving materials and reducing the overall building costs. The use of a C60/75 strength class concrete can reduce the volume of the vertical elements still further. This has the additional benefit of increasing the net lettable area.

FLEXIBILITY

Cost savings are also possible with the use of post-tensioned (PT) concrete floor slabs. PT offers several benefits, not least of which is the fact that the PT floor slabs are generally thinner than an ordinary reinforced concrete slab. They can be up to 300 mm thinner over one storey than a steel frame. This minimises the building's height to the extent that this could mean an extra storey on a ten-storey building.

PT slabs can economically span further than a reinforced concrete slab. This in turn reduces the required number of columns and foundations, and increases flexibility for space planning. The clear flat soffits of PT slabs enable complete flexibility of service layout. The absence of trimming beams around service cores avoids conflicts between services and structure. There is also flexibility in positioning holes through the slab because tendons are widely spaced and can be positioned around openings. In addition to the above benefits, PT allows for rapid construction. Less reinforcement reduces fixing time and early stressing of the concrete allows the formwork to be struck quickly.

Above all, the use of high-strength concrete or PT allows for thinner structures. The thinner the overall structural frame, the lower the cladding costs. Given that cladding can represent up to 22% of the construction cost, minimising the cladding area represents considerable savings.

For the skylines of many of our cities, the only way is up. The inherent performance benefits of reinforced concrete suggest that this journey is both fast and economical.

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HUNTER EXPRESSWAY PAVES THE WAY

CONCRETE PAVEMENTS WERE CHOSEN FOR A MAJOR PORTION OF THE HUNTER EXPRESSWAY WHICH IS A VITAL LINK BETWEEN THE IMPORTANT EXPORT CITY OF NEWCASTLE AND THE UPPER HUNTER RIVER REGION OF NEW SOUTH WALES.

BACKGROUND

The forty kilometre, four lane, dual carriageway expressway provides a more direct and efficient route for freight movements between the Upper Hunter coal fields and the export facility of Newcastle. The Port of Newcastle is the busiest port in New South Wales, handling seventy five percent of the State's total international trade. This level of heavy traffic punishment demands a pavement of the superior strength and durability that only concrete provides.

DESIGN & CONSTRUCTION

Concrete pavements are renowned for their long life and low maintenance especially when the going gets tough. They provide a service life of forty years under the most extreme of conditions and will do it with minimum fuss. They are an invaluable asset to the Hunter Expressway as the main artery to the Newcastle International Port. Export movement at Newcastle doesn't stop and neither can its main supply artery. This is the level of dependability that's demanded and this is the level of reliability that concrete pavements deliver.

The Hunter Expressway project was complex and large and was divided into two sections for contract. The Eastern section was thirteen kilometres long and was designed and constructed by the Hunter Expressway Alliance consisting of: Roads and Maritime Services of New South Wales, Thiess Pty Ltd, Parsons Brinckerfhoff and Hyder Consulting. The Western section was twenty seven kilometres long and as a design and construct contract was completed by Abigroup Contractors Pty Ltd. The total value of the project was $1.7 billion with the Federal Government providing almost ninety per cent of the funding.

The project is one of the biggest in the Hunter Region, and as it traverses significant environmentally important areas it was built to strict environmental standards. As a challenging project concrete provided the solution. Varying foundation support conditions required a variety of pavement solutions and consequently two forms of concrete pavement were used in different job sections: utilising both Plain and Continuously Reinforced varieties of Concrete Pavement.

The first form was a Plain Concrete Pavement consisting of a 280 mm thick 35 MPa Base constructed over a 150 mm thick 5 MPa Subbase. The second form was a Continuously Reinforced Concrete Pavement consisting of a 250 mm thick 35 MPa base constructed again over a 150 mm thick 5 MPa subbase. In both cases the base was debonded from the subbase with a 7 mm spray seal over a wax curing compound.

The Plain Concrete Pavement contains no steel reinforcement and utilises a system of transverse and longitudinal jointing to manage cracking behaviour. The Continuously Reinforced Concrete Pavement has continuous longitudinal reinforcing steel consisting of N16 bars at 120 mm centres with the transverse steel consisting of N16 bars at 400 mm spacing.

DIAMOND GRINDING

An interesting initiative that was undertaken on some of the concrete pavements in the Hunter Expressway is a surface treatment called Diamond Grinding. In this process small width longitudinal grooves are cut into the surface after the concrete has hardened.

This process delivers a road surface texture that produces a smoother vehicle ride with increased traffic traction and lower perceptible traffic noise: providing a world class road surface texture. With the innate strength and durability of concrete this world class pavement is there for keeps.

OVERALL BENEFITS

Using concrete as the actual trafficable road surface holds considerable benefit and advantage in terms of the low cost of annual maintenance. Concrete is a strong, robust and durable material that resists erosion and deterioration under the rigorous and demanding punishment of traffic.

Concrete pavements durability and strength reduce the need for extensive maintenance and rehabilitation of road surfacing giving a benefit to the road network and a saving to the taxpayer. Additionally concrete pavements allow a road network manager respite from the never ending and ever increasing road maintenance burden allowing greater control over pavement system management.

Concrete pavements having less repair requirement require less repair downtime, improving traffic access and flow and give a superior service to the traffic network.

The Hunter Expressway, as a valuable gateway to the important export city of Newcastle, requires a dependable and reliable pavement. Concrete pavements provide that dependability and reliability producing a motorway that performs and lasts under extreme conditions. When strength, durability and performance are required concrete pavements are the answer.

Article reproduced with kind permission from Cement Concrete and Aggregates Australia (CCAA).

PEANUT ROUNDABOUT REVISITED

LOCATED CLOSE TO THE PORT OF NAPIER, THE "PEANUT ROUNDABOUT" IS OFTEN CITED BY CCANZ AS A NEW ZEALAND EXAMPLE OF A WELL-PERFORMING CONCRETE PAVEMENT FOR LOW SPEED, HIGH STRESS APPLICATIONS.

This intersection on SH50 was completed under Transit NZ guidance by Works Infrastructure in mid-2006, and carries most of the fully laden trucks bound for the Port of Napier. It has a long history of surfacing distress due to the tight curvature and high volumes of heavy vehicle traffic.

The brief for the project was to design and construct a sound and rigid concrete pavement that provided adequate skid resistance for the traffic environment. In addition, construction of the road had to be finished with minimal delays to the travelling public.

Construction of the roundabout was completed in just five days. On the first day, the existing pavement was removed and stockpiled, the subgrade prepared and the proof rolled. On day two, the stockpiled pavement was stabilised and the surface prepared for concrete.

On day three, the road was concreted and cured. Concrete with a compressive strength of 30 MPa was used along with mixed grades of sealing chip and crushed aggregates. Polypropylene and structural synthetic fibres were used to reduce plastic shrinkage and increase flexural strength respectively. The concrete was screeded by hand, delivered at 60 mm to 80 mm slump, and superplasticised to around 110 mm in order to achieve the desired workability.

Poorly designed and constructed joints can lead to differential settlement. To overcome this, dowelled joints at 200 mm centres were employed at regular 5m intervals transversely along the road to suit the road geometry. The concrete was poured directly up to the cut edges, with no local thickenings or slab anchors used.

On day four the joints were saw-cut, and on day five the line marking was completed, and the road opened once adequate concrete strength was confirmed.

Image: Google Earth

Since the roundabout was completed, the pavement has performed well. Although some longitudinal cracking is evident it is not related to stress, and is more likely to have been the result of shrinkage during curing. Expected wearing of the surface has occurred in the running path, while in the low-speed environment skid resistance is not compromised.

Deemed successful as a learning experience by the NZTA, particularly in terms of site selection (tight curvature / slow speed / alt route during closure), design and construction, the intersection accommodates more than 1200 heavy commercial vehicles per day, meeting the NZTA's highest criteria threshold level of "national strategic high volume".

The use of concrete in road pavements is a practical way of providing a long-term durable solution for highly stressed local sections of roads. As demonstrated by this site, a sound pavement structure, adequate surface texture, and constructability during a short time period can all be achieved with the use of concrete.

Hart, Gordon & Johnson, Richard. (2006) Concrete roads for high stress applications. Proceedings of the Transportation and the Pursuit of Excellence, NZIHT & Transit NZ 8th Annual Conference. Auckland, New Zealand.

ASK ALISTAIR

CCANZ STRUCTURAL ENGINEER ALISTAIR RUSSELL EXPLORES HOW TO AVOID CONCRETE CRACKING.

HOW TO AVOID CONCRETE CRACKING

WITH SUMMER FAST UPON US WE HAVE ENTERED THE HIGH-RISK PERIOD FOR EARLY AGE CONCRETE CRACKING. HIGHER DAYTIME TEMPERATURES AND DRY WINDS ALONG WITH LOW EVENING TEMPERATURES ARE A PERFECT RECIPE FOR THE CREATION OF CRACKS.

If you want to minimise the time spent investigating and rectifying unwanted cracks in concrete, now is the time to understand the issues and the action you can take to avoid problems. This article looks at cracks which form in concrete after it has been placed but before it has set – when the concrete is in its plastic state.

PLASTIC CRACKING

The formation of cracks in concrete is somewhat inevitable; and can form prior to the concrete setting, or after it is in its hardened state. During the setting stage, the moisture content of the concrete changes and water is given off, and hence the concrete shrinks. This shrinkage leads to a volume change, and as concrete has a low tensile strength, if this volume change is restrained, cracks will form. However, appropriate measures can minimise at the very least, or eliminate entirely, the formation of these unwanted cracks.

Cracks which form before the concrete has fully hardened (usually not less than about eight hours) are known as plastic cracks. Plastic cracking occurs as either shrinkage cracks or settlement cracks.

PLASTIC SHRINKAGE CRACKS

Once concrete is in place, evaporation can only occur from the free surface. In the absence of appropriate precautions, and in unfavourable drying conditions, the rate of evaporation at the surface can be greater than the rate with which water within the concrete can migrate to the surface to make good the loss. The highest risk weather for plastic shrinkage cracking is sunny and/or windy days with low humidity levels.

After concrete has been placed, vibrated, screeded and floated, it is left so the bleed water can rise to the surface. The slab cannot be finished until it is hard and the bleed water has evaporated. The bleed water will appear within about 15 minutes of placing and the slab is ready for finishing after several hours, depending on the concrete temperature. If the top surface is allowed to dry before final finishing, then plastic shrinkage cracking may occur.

The risk of plastic shrinkage occurring is greatest when:

- The temperature difference between the concrete and air temperature is large. In spring, this type of cracking can occur in an area exposed to the sun, while shaded concrete remains uncracked. Concrete exposed to the sun can be significantly hotter than the air temperature.
- Low bleed concrete mixes (e.g. superplasticised mixes and/or mixes with high quantities of ultrafines) are used. The more concrete bleeds, the less likely it is that the surface will prematurely dry out. As such, greater precautions are required when using low bleed concrete mixes.
- There are low humidity days.
- There are high wind speeds.

What do plastic shrinkage cracks look like?

Usually, the cracks occur either while finishing or within 30 minutes to six hours of finishing, and form without any regular pattern and may range from 25 mm to 2 m in length. They may be straight or jagged and often intersect each other forming T junctions or acute angles. The cracks vary in width from a hairline to perhaps 3 mm. Additionally, while they are surface related the cracks may extend deeper with subsequent drying of the slab.

Figure 1: Plastic shrinkage cracking

How can plastic shrinkage cracking be avoided?

The most effective way to reduce the risk of plastic shrinkage cracking is to prevent rapid loss of moisture from the surface of the concrete. Practices to achieve this are:

- Dampen the subgrade and formwork, while also ensuring any excess water is removed prior to placing concrete.
- In hot weather, lower the temperature of the fresh concrete by using cool aggregates if possible.
- Erect wind breaks to reduce wind velocity over the concrete surface.
- The use of polythene sheets on the top surface of the concrete

will prevent both evaporation and air movement. These should be used with caution though when trying to obtain a consistent colour to the slab.

- Use a proprietary evaporation retardant spray. These are inexpensive and provide a good degree of protection if used in accordance with the manufacturer's instructions.
- Add polypropylene fibres to the concrete mix. The use of polypropylene fibres works by evenly distributing many small reinforcement fibres throughout the mass of the concrete in all directions and intersecting any micro-cracking that occurs when the concrete shrinks. Their physical properties are designed to match the properties (e.g. the modulus of elasticity) of fresh concrete, and polypropylene fibres usually provide sufficient extra strength to prevent micro-cracks from widening and hence restrict the formation of plastic shrinkage cracking. Fibres are typically added at the batching plant and therefore their use requires planning. Your ready mix concrete supplier will be able to advise on the appropriate dosage.
- Commence curing promptly after finishing is complete and ensure the surface is subject to continuous curing. Providing a fog mist spray to increase humidity above the concrete is a good means of achieving this, although may be difficult to get a uniform application during windy conditions. It is important excess water is not added to the surface.

PLASTIC SETTLEMENT CRACKS

Another form of cracking which occurs during the plastic stage of the concrete setting process is *plastic settlement cracking*.

Most concrete, after it is placed, bleeds. This means that water rises to the surface as the solid particles settle. The bleed water evaporates and there is a loss of total volume (i.e. the concrete has 'settled'). If there is no restraint, the net result is simply a very slight lowering of the surface level. However, if there is something near the surface, such as a reinforcing bar, which restrains part of the concrete from settling while the concrete on either side continues to drop, there is potential for a crack to form over the restraining element.

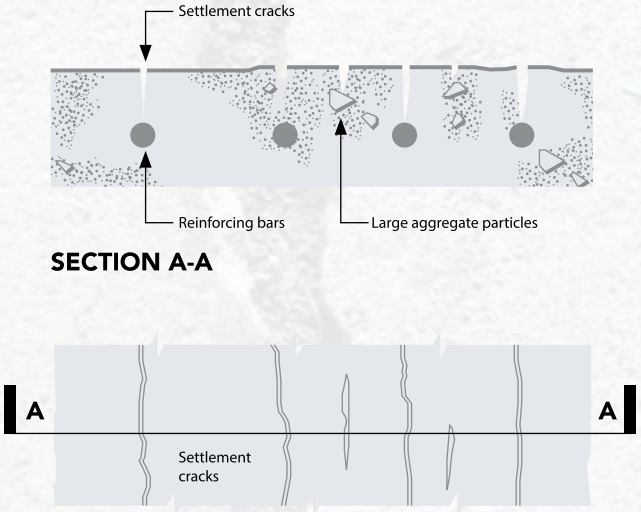

Figure 2: Settlement Cracking

Figure 3: Settlement Cracking

Settlement cracks tend to follow a regular pattern replicating the lines of restraint, usually the reinforcement, or a change in section. Generally, the cracks are not deep but, because they tend to follow and penetrate down to the reinforcement, they may reduce the durability of a structure.

Plastic settlement is affected by the following factors:

- Rate of bleeding from the concrete
- Time over which settlement can take place, i.e. the time before set
- Depth of reinforcement relative to total thickness of the section
- Size of reinforcement
- Constituents of the mix
- Slump

PREVENTION OF PLASTIC SETTLEMENT CRACKING

Plastic settlement cracks may be prevented, or rather closed, by revibrating the concrete after settlement is virtually complete and it has begun to set. However the timing is critical and considerable experience is needed to know when that critical time is. If revibration is done too early, more settlement could occur, and if it is done too late it could damage the bond between the concrete and reinforcement.

Other procedures which may help reduce plastic settlement cracking include using:

- Lower slump mixes
- More cohesive mixes
- An air entrainer to improve cohesiveness and reduce bleeding
- increasing cover to top bars

With an understanding of the causes and precautions that can be taken to avoid plastic cracking, this common surface defect can be easily controlled.

The CCANZ Information Bulletin *IB 73 Cracking* contains more information about concrete cracking, and is available for download from www.ccanz.org.nz.

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100 CONTEMPORARY CONCRETE BUILDINGS BY PHILIP JODIDIO

Concrete? That characterless stuff of parking lots or Communist tower blocks, right? Well, yes and no. Concrete is actually a name applied to a remarkably wide range of building substances, and, when properly handled, is one of the noble materials of contemporary architecture. A kind of "liquid stone" at the outset, it is malleable, durable, and capable of prodigious feats of engineering.

This two-volume book highlights the best work done in concrete of recent years. It includes such stars as Zaha Hadid, Herzog & de Meuron, and Steven Holl, but also surprising new architects like the Russians SPEECH, and rising stars of the international scene like Rudy Ricciotti from France, as well as artists such as James Turrell, who turned the famous concrete spiral of Frank Lloyd Wright's Guggenheim in New York into the setting of one of his most remarkable pieces.

CONCRETE: PURE: STRONG. SURPRISING BY CHRIS VAN UFFELEN

Tracing its origins as far back as ancient Rome, reinforced concrete became the world's most widely used construction material during the second half of the 20th century. After a period of excess and architectural faux-pas, a renaissance of exposed concrete began in the 1990s. Whether the design is expressive-opulent or minimalistic-clear, advances in concrete technology have now made possible truly amazing structures. This book showcases contemporary examples of such buildings.

LIBRARY QUIZ

To go in the draw to win a copy of *100 Contemporary Concrete Buildings by Philip Jodidio* answer the following simple question:

What NZTA classification does Peanut Roundabout at the Port of Napier hold?

Email your answer to library@ccanz.org.nz.
Entries close Friday 29 January 2016.

Congratulations to Tiffany Lester of Opus Research, who correctly answered the Vol 58 Iss 2 Library Quiz to receive a copy of *The Issues and Discussion of Modern Concrete Science* by Wenke Yang.

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NEWS FROM THE ASSOCIATIONS

NZCS New Zealand Concrete Society — NEW ZEALAND CONCRETE SOCIETY (NZCS)

CONFERENCE STRIKES THE RIGHT NOTES

Robust technical content, great venue, faultless organisation and an excellent social calendar – just some of the descriptors volunteered by delegates attending the annual Concrete Conference in Rotorua in October.

Some 330 delegates and 25 trade exhibitors attended this year's conference. As always, said Carl Ashby, the Concrete Society's immediate past president, the conference proved to be a valuable focal point for the concrete and construction industries.

"It's always been an excellent opportunity for representatives from all industry sectors to get together, catch up on emerging trends and technologies, exchange ideas, establish contacts – or simply relax with old friends.

The conference patrons, sponsors and trade exhibitors deserved special thanks for making it all possible. "Without them it simply could not happen," said Carl.

CONCRETE AWARD WINNERS

Credit: Memorial Park Alliance.

A 300 m tunnel built under Wellington's Pukeahu National War Memorial collected three of the six awards at the recent NZ Concrete Society "recognising excellence" celebrations. The project received the Landscaping and Infrastructure Awards, as well as the overall Supreme Award.

By taking traffic underground, the new tunnel project allowed for the expansion and redevelopment of the original Memorial park. It now features a 21,000 m^2 area of boulevards and terraces, skilfully integrated into the overall infrastructure.

Convenor of judging panel, Paul Wymer, says the project presented enormous challenges and demanded innovative solutions.

"A cut-and-cover trench project, the structure is designed to withstand a 1-in-2500 year earthquake – no small feat considering crews had to contend with difficult land formations, a high water table, huge seismic-induced soil pressures and a historic sewer. They also completed the work in a restrictive environment – a narrow, busy traffic corridor."

Construction involved some 7,500 m^3 of concrete – used structurally as well as symbolically. Concrete provides permanence and longevity, ensuring the future of the tunnel and park as a national commemorative site.

Another multiple award winner on the night was a home overlooking Waiheke Island's Hekerua Bay. It received the Monte Craven Architectural Award as well as the Residential Award.

Christchurch's new Ferrymead Bridge received a commendation in the Infrastructure category, while a home in Auckland's Remuera suburb was commended in the Residential category.

The Technology Award was won by the ArchEng Student Workshop 2014 - an educational initiative which encourages architectural and engineering students to work together. Commended in Technology category was the JPL Distribution Centre. This project required an exceptionally flat and level floor for a state-of-the-art warehouse.

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