


concrete

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LIVING CONCRETE

With public concern growing about weathertightness and durability of lightweight materials, New Zealand apartment developers are increasingly choosing to build in concrete. Here we look at three high quality residential developments nearing completion in Wellington, Christchurch and Tauranga, in which concrete features extensively.

The Est@blishment in Christchurch, Wellington's Sanctum Apartments and Tauranga's Devonport Towers, aim to set a new benchmark in the delivery of multi-unit housing.

The Est@blishment

The Est@blishment is an exclusive development in the heart of Christchurch, incorporating some of the largest contemporary apartments in New Zealand. It features five apartments, each with a net living area of 280 m^2 (plus additional garaging and storage areas), and two penthouse suites of around 450 m^2.

The structural system comprises reinforced precast concrete and concrete slabs, and the exterior walls and walls around the lift shaft are of reinforced concrete. The slabs were cast off-site, in the yard of contractor C.S. Luney, which helped speed up construction. The floor system is unispan concrete with cast-in-place concrete toppings.

Engineer Grant Coombes, of Alan Reay Consultants Ltd, says that the extensive use of concrete has resulted in a building of significant durability. "Very few lightweight materials have been used in the construction," he says.

"The building has been designed with concrete walls as the primary lateral and gravity load resisting system. The walls, all cast off-site and transported, varied from 2 to 4 levels in height, to minimise joints. Walls generally provide a stiffer building than frames and this is appropriate for a luxury apartment building."

"Moreover, the thermal mass of the concrete means that the buildings will have improved temperature stability. This will aid in the prevention of overheating in the summer and retain warmth in the winter."

The acoustic benefits of concrete are significant when used for a central city apartment complex. The reduction of external plant, equipment and traffic noise, and of internal sound transmission from adjacent apartments, was a priority for the Est@blishment.

"The concrete floor slabs, together with concrete walls, and in conjunction with double glazing and insulated pipe and duct-work, provides superior acoustic insulation," adds Mr Coombes.

Artist's impression of the completed Est@blishment - image courtesy of Warren and Mahoney

The watertable on the development site is high, with a constant head of pressure behind the walls of the basement, which houses resident parking and storage facilities. Traditionally, tanking would be used to ensure adequate drainage and prevent leaking. Instead, the engineers have used waterproof concrete (treated with waterproofing additives) and carefully designed joints that feature water-stops.

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WHAT'S INSIDE....

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Cement & Concrete Association of New Zealand

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Architect Peter Marshall, of Warren and Mahoney, says concrete is an integral part of the building's aesthetic appeal. "The concrete frames are expressed and painted a contrasting colour to the concrete panels, reinforcing the structure and integrity of the building," he says.

Sanctum

Concrete's benefits in terms of solar gain, soundproofing and durability were a fundamental consideration in the Warren and Mahoney designed Sanctum apartments in Wellington. The development, located in the 'Courtenay Corner' of Wellington's central café and bar area, comprises two eight-storey reinforced concrete blocks with a total gross floor area of 6,310 m^2, providing 96 apartments. There is a separate gymnasium and swimming pool structure, plus car parking and storage facilities with a gross floor area of 4,130 m^2.

Sanctum viewed from the formal gardens - artist's impression supplied from Warren and Mahoney.

Neill Kerkmeester, Project Manager for Multiplex Construction, the main contractor for the development, described the extensive use of concrete in the structure.

"The apartment structure consists of a Raft Slab, and insitu beams, columns and shear walls up to level two. Cast insitu shear walls and exterior precast concrete panels continue from level two to eight. Precast Double Ts, supplied by Stresscrete (Otaki), were adopted for all floors; precast panel stair and lift shafts are located at the end of each apartment block."

"The four-storey carpark building consists of a single level concrete basement with a structural steel frame to the three floors and roof above. Suspended slabs have been constructed utilising the Speed Floor system, supplied by P&A Construction Ltd, of rolled steel joists, temporary plywood soffit and a 90 mm thick cast insitu concrete slab."

Cast insitu work and precast concrete placement was done by Formco Construction and Development Ltd, with precast concrete panels supplied by Precast Components (Wgtn) Ltd. Allied Concrete supplied the concrete.

The units have been designed so that no apartment faces south or to the rear - all look out over a central formal garden, and are north or west facing, ensuring maximum sun. This, combined with the predominance of concrete, means that the apartments will benefit from extensive passive solar gains, requiring less heating in winter (and less cooling in summer).

"Noise control is a major issue in the central city," says architect Ralph Roberts. "Using concrete as a fundamental component of the design has ensured that minimum soundproofing has been exceeded."

"We have worked closely with acoustic engineer Marshall Day to further improve sound proofing to the extent that an acoustic engineer (from another firm) has purchased an apartment on the ground floor!"

The use of reinforced concrete, under the direction of Structural Engineer Barry Ramsay, has also added to the seismic strength and durability of the buildings, a significant consideration in earthquake-prone Wellington.

"The durability of the concrete means that Sanctum purchasers can be confident their investment is solid, of high quality and low maintenance," Mr Roberts said.

Devonport Towers

The Devonport Towers apartment complex, designed by Mark Tatton of Tauranga-based firm MTD Architecture, will change the Tauranga seafront's skyline dramatically when it is completed later this year.

Overlooking the harbour and marine facilities, the complex will be Tauranga's highest building. Although modest by metropolitan standards, the 16-storey structure is the highest permitted by the airport height restrictions in the District Plan.

Redco, a Tauranga-based firm of Engineering Design Consultants, designed the structure for H&H Projects - the developer and builder of the apartments. Paul Bowker, the proprietor and project manager of H&H Projects, after consultation with Redco's engineers, opted for a steel-framed structure with precast concrete shear walls and exterior panels.

"The precast concrete floors easily satisfied the fire rating and sound insulation requirements of the design," Mr Bowker said.

Originally a proprietary composite (metal deck) flooring system was chosen and incorporated in the design. These flooring systems have very short spans and / or require extensive propping during construction. However Smithbridge Precast engineered an alternative solution using a 200 mm variation of its Super Tee - a 3 m wide double-T prestressed suspended floor system.

The cost and time savings of Smithbridge Precast's alternative solution were readily apparent to Redco and H&H Projects.

Paul Sweetman, the manager of Smithbridge Precast, points out that the cost advantage of the prestressed concrete floor system is due to its much greater span, which reduces the number of secondary beams required.

"When the original design and Smithbridge's alternative were analysed and compared, the latter was a much more cost-

Artist's impression of the completed Devonport Towers structure - courtesy of Redco.

effective solution - even when the cost of the redesign was taken into account," Mr Sweetman said.

"Moreover, the number of crane movements was reduced, as each section of Super Tee covered approximately 20 m^2 of floor space," he said.

"This, along with the fact that the Super Tees provided an immediate safe working deck for subsequent operations, and didn't require propping during the pouring of the topping slab significantly contributed to speed of construction."

Greg Jensen of Jensen Steel Fabricators, who erected the steel and placed the Super Tees, is impressed with the slickness of the precast units.

Paul Bowker is very pleased with the way the project has developed, the economy, speed and simplicity of the chosen construction method, and the fact that the height between the 1000 m^2 floors has been minimised to 3 m by adopting the Super Tee flooring solution.

Other contributors to this successful project are Stresscrete, who supplied some of the 100 mm thick precast concrete cladding panels, Unispan and other precast slabs for the balconies. Cast-in-place concrete for the piles (which were driven by Smithbridge) basement floor and suspended floor toppings was supplied from the Allied Concrete Plant in Tauranga.

Allied Concrete also supplied the concrete to Smithbridge Precast for the Super Tees, Unispan 200 mm thick basement shear wall panels, basement cladding panels, stair flights, landings and some of the 100 mm thick cladding panels and 175 mm thick retaining panels.

Concrete Power!

Recent studies show concrete homes could be one answer to New Zealand's energy crisis.

According to a new paper by Morten Gjerde from Victoria University's School of Architecture and Chris Munn of CCANZ, concrete homes use significantly less energy, and need less maintenance than those constructed from lightweight materials.

The paper, which was presented by Mr Gjerde at the Concrete Institute of Australia's annual conference in July, reported on studies comparing initial capital costs, energy use, relative comfort levels, total energy used, and maintenance costs of houses made from concrete masonry, monolithic cladding and brick veneer with timber framing, in Christchurch and Auckland.

It was found that total energy use and related monetary cost associated with building and operating a home was significantly less for a concrete home than for those built using timber frame or monolithic cladding construction. Over a 50 year period, energy savings were calculated at 17% in the Auckland environment and 8% in Christchurch.

Mr Gjerde said that given the recent problems associated with weatherproofing of timber homes, not only was it likely that maintenance costs for lightweight homes would be significantly higher, but in some cases it could be necessary to replace such a home in its entirety during a 50 year period.

"The initial cost of building in concrete is only marginally higher than other building materials - and the long-term benefits far outweigh the initial outlay, particularly when you consider the costly repair bills many homeowners are now unfortunately facing," he said.

"In addition, with New Zealand's dwindling natural gas reserves and rising electricity and costs, the demand for concrete homes which are thermally comfortable and energy efficient is likely to increase significantly within the next few years."

A copy of this paper can be viewed at http://www.cca.org.nz/pdf/munngjerde.pdf

The Concrete Menagerie

Demand for concrete sidewalk barriers - a first line of defense against the potential threat of car and truck bombs - has increased in the US since September 11 and is set to continue rising, with the revival of the country's economy.

However, traditional concrete barriers can often be seen as unattractive, jarring with the surrounding urban architecture. To overcome the 'ugly' factor, security solutions specialist Secure USA is now producing concrete sculptures in the shape of various animals which provide aesthetic appeal as well as security. Included in this concrete menagerie are bollards in the shapes of gorillas, elephants, pandas and whales - with optional water spray attachments.

ICF AGAINST TERRORISM

Insulating concrete form (ICF) building systems have been shown to be extremely effective in withstanding explosions. USA's Insulating Concrete Form Association (ICFA) tested six different ICF 'reaction boxes' using military grade TNT explosions, at the Quantico Marine Corps Base. No structural damage, deflection or spalling of the concrete resulted from the explosions - the only effect was some small cracks on the wall faces and singeing of the expanded polystyrene. Further tests are planned.

Cook's Clinic...

Colour Variations in Formed Finishes

The topic of formed concrete surfaces was covered in the previous issue of *concrete* from the perspective of understanding the cause of some physical defects. In this issue we continue this thread and explore the causes of colour variation in formed surfaces.

It is important to first note that concrete is a natural material and will always exhibit some colour and shade variations. This natural variation is often the attribute that designers wish to capture in their designs.

NZS 3114 "Specification for Concrete Surface Finishes" provides 6 form finishes classes (F1 to F6), and the allowable colour variation specified for these classes are summarised in table 1.

Table 1 Colour variation requirements for various formed finish classes

Finish	Description	Colour variation
F1	Surface where roughness is not objectionable	No special provisions need to be made to reduce the incidence of colour variations, banding, surface retardation, efflorescence or dusting.
F2	Surface which provides key for plaster	Precautions shall be taken to prevent dusting or efflorescence, but no special precautions to reduce colour variations.
F3	Surface which is not prominent or subject to close scrutiny	As per F2
F4	Surface where appearance is moderately important and frequently observed	The limits of colour variation shall be based upon sample panels, and precautions shall be taken to avoid the incidence of discolouration, contamination, dusting, retardation, and efflorescence.
F5	Surfaces where appearance is importance and frequently subjected to close scrutiny	As per F4
F6	Appearance is of greatest importance	As per F4 but extra care regarding formwork rigidity

Table 2 provides a summary of colour variations and their causes.

Table 2 Colour variations and their causes

NOTE: Some of the undermentioned defects may lessen or disappear with time, especially on surfaces exposed to weathering, but it is not practicable to state exactly what can be expected to happen to any given surface. Some defects may appear sooner than others after stripping the forms.

		Most probable causes			
Defect	Description	Materials	Concrete Mix	Formwork	Other
Inherent colour variation	Variation in colour of the surface.	change of cement brand change of source of fine and coarse aggregate variation in admixtures	variations in mixing procedure		
Aggregate transparency	Dark areas of size and shape similar to the coarse aggregate. Mottled appearance.		low sand content gap grading of sand	too flexible, causing a 'pumping' action during compaction	*Placing methods* excessive vibration
Negative aggregate transparency	Light areas of size and shape similar to the coarse aggregate. Mottled appearance.	aggregate dry or highly porous			*Curing* too rapid drying

Defect	Description	Most probable causes			
		Materials	Concrete Mix	Formwork	Other
Hydration discolouration (due to moisture movement within or from plastic concrete)	Variation in shape of the surface. Hydration staining and discolouration have a tendency to be severe at the top of a lift and at construction joints due to localised variations in water-cement ratio, incomplete compaction, and differential loss of moisture. Indentation of construction joints tends to disguise this discolouration by throwing the affected areas into shadow.			variable absorbency leaking through joints	*Release agent* uneven or inadequate application *Curing* uneven
Segregation discolouration or sand runs (separation of fine particles due to bleeding at the surface of the form)	Variation in colour or shade, giving a flecked appearance	low absorption	lean, high water-cement ratio unsuitably graded aggregate		*Placing methods* excessive vibration low temperature
Dye discolouration or contamination	Discolouration foreign to the constituents of the mix			stains, dyes, dirt on form face, timber stains, rust from reinforcement or metal form components	*Release agent* impure or improperly applied *Mix materials* dirty contaminated by pyrites, sulphates, clay, organic matter or other impurities *Curing* impure curing compounds dirty covers
Oil discolouration	Cream or brown discolouration. Sometimes showing sand or coarse aggregate				*Release agent* excessive amount low viscosity impure applied too late or unevenly
Lime bloom or efflorescence	White powder or bloom on surface				*Design* permitting uneven washing by rain *Release agent* type *Curing* uneven conditions
Retardation dusting	Matrix lacking in durability. Dusty surface which may weather to expose aggregate and which will erode freely under light abrasion at early ages, particularly in the period immediately following stripping of formwork			timber or plywood linings, the faces of which have had prolonged exposure to sunlight retarder in or on form faces loss of contact between form face and hardening concrete (rapid drying)	*Release agent* unsuitable excessive use of chemical release agent water soluble emulsion cream* unstable cream oil with excessive surfactant *Curing* inadequate (very rapid drying)
Banding	Coarse texture corresponding to the width of the slipform, the bands often being of different colour				*Slipforming* stop-start method of slipforming hardened concrete behind slipform cannot be finished off at the same age as the rest and has different hydration conditions a more nearly continuous slipform motion causes less prominent banding

**Cream refers to an emulsion of an oily constituent in water.*

Residential Suspended Concrete Floors

While the concrete ground floor slab is a common feature in New Zealand homes, suspended concrete floors have been slower to catch on.

In fact, suspended concrete floors offer many benefits for residential buildings. Used as part of a steel or concrete system, suspended floors offer excellent structural performance.

They are cost-effective over spans greater than six metres and offer the same excellent thermal advantages as concrete slab-on-grade floors. The high mass of a suspended concrete floor combined with lack of jointing ensures that sound can be effectively dampened, which produces a quieter floor.

In addition, suspended floors offer speed and efficiency of construction and are also versatile, easily accommodating slopes and changes in level. Holes can be cut to accommodate services.

Several types of suspended concrete flooring systems are available. Some of the more common profiles are illustrated in figure 1. All include a layer cast on-site to knit the units together. Precast concrete floors span between structural supports.

The fire resistance of concrete floors is largely determined by concrete cover to reinforcing steel. Suspended floors can be designed to a range of fire rating requirements, and will generally outperform timber-based fire ratings. Precast floor units can be pre-stressed to increase structural efficiency, resulting in reduced weight, longer spans and less section depth. Fabrication in factory conditions gives the units a consistent quality of strength, durability, and finish, and eliminates the need for on-site formwork.

When using a precast suspended concrete floor system, the units must be designed and detailed to allow for safe handling, including safe means of removing lifting tackle after the units have been placed. Particular care should be taken where the units may need to be tilted or twisted into position. Plan thoroughly for the suitability and adequacy of supports. The underside of a suspended floor slab can be caulked and painted or have a ceiling lining applied to it. Alternatively, a ceiling system can be suspended from the slab allowing space in which to run services. Consideration should be given to the point loading of walls, beams or lintels when the floor units are being placed.

Careful thought must also be given to the construction sequence and to the effects caused by the temporary removal of parts of the structure, in order to facilitate the safe installation of the units. All precast flooring units require a screed or structural topping layer. The topping increases the fire resistance of the suspended floor, conceals any surface irregularities and can accommodate underfloor conduit for services wiring.

However, when the applied floor finish is to be pad and carpet, the topping may be omitted if smooth-surface precast units are used. A minimum period of 72 hours should be allowed after casting a floor, allowing time to achieve sufficient strength and

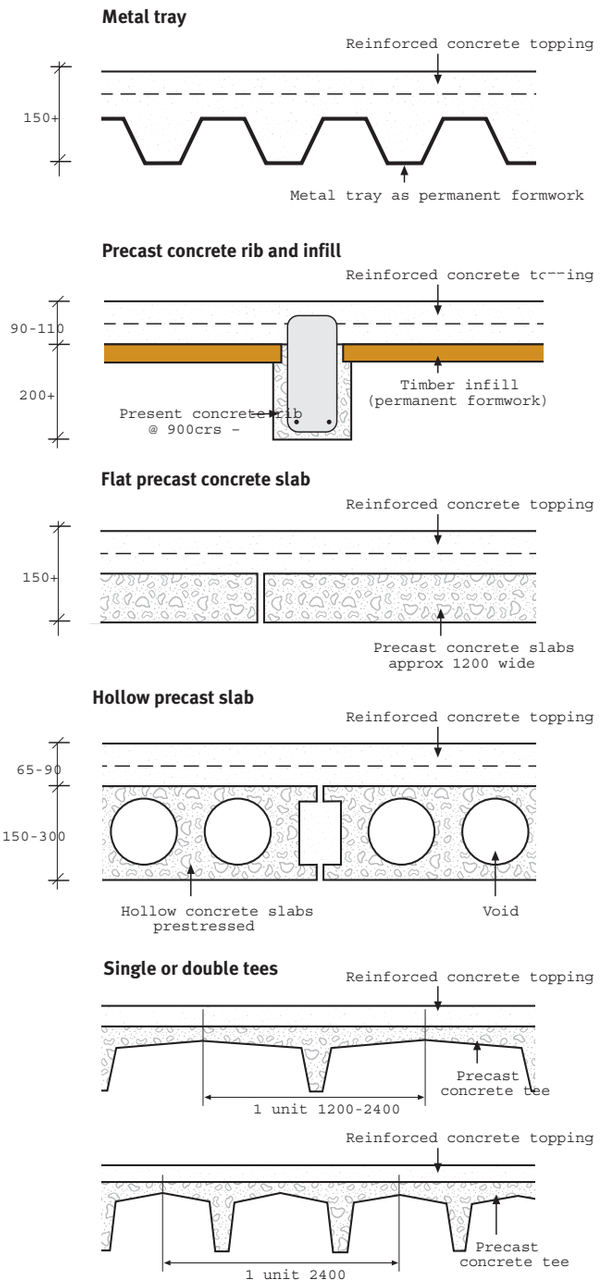

Figure 1: Various types of suspended concrete floor systems (not to scale).

stiffness to support load. It is important when using a floor system with a topping, to remember that provisions should be made for the imposed loads of this extra layer.

The method of off-loading and placing of the units will be determined by the size and weight of the components. If the precast units are to be stored at ground level, it is necessary to ensure that the ground or surface on which the components are to be stacked is firm and level. Wherever possible, components should be stacked on firm hard-fill or cured concrete.

International news...

THREE DAY WONDER

A German company has just made a major breakthrough in affordable concrete housing.

German company Lösch Systembauteile GmbH + Co. KG has constructed a pilot home in Annweiler which features 160 square meters of floorspace, and can be built in just three days - at a price of just 100,000 Euro (around NZ$200,000).

Managing Director Wilhelm Orth said while speed of construction was a consideration in developing the model, the main focus was on cost-efficiency and quality rather than breaking any speed-building records.

Placing the concrete for the 20 cm-thick concrete base slab took two workers only one hour because of a new "self-compacting" concrete mix with steel fibers. This recipe removes the need for labour-intensive armoring and guarantees high load-bearing and an absolutely crack-free slab.

All walls are made from 10 cm-thick reinforced precast concrete units, a thickness which is sufficient to construct houses up to five storeys high. Together with 15 cm of insulation, the overall wall construction reaches a thickness of 25 cm and has a U-value of 0.22. This is equivalent to a 70 cm thick brick wall.

The windows are placed directly in the precast units which saves cost because the precasting factory does not have to construct any timber shutterings for the recesses for the windows and there are no shutterings to dispose of afterwards - the shuttering is the window itself.

The window builder does not have to fill the tolerances between window and wall with polyurethane foam and silicone, because the window is in direct contact with the concrete. All points of weakness with such a joint are eliminated - all this with less effort than is required with conventional methods.

The window details are formed so that the frame is covered by the insulation, forming a tight seal against the wind. The slatted roller blind housings complete with insulation are fitted on the outside, removing the infamous heat bridge.

All electrical installations are integrated complete with conduit in the precast units, cutting out the cost-intensive task of making slots in the walls. The walls on the ground floor are not held together by welding and bolting but by an interlocking connection similar to the Lego building-block principle.

The floor slab complete with underfloor heating is completely even, so floorcoverings can be laid without any need for screed. The walls and the underside of the floor slab are completely flat and ready for painting or wallpapering. Installation ducts have been included within the walls so electric/ electronic equipment and devices can be moved to different rooms without the need for additional drilling.

The patio comprises two precast concrete slab units with a gradient on one side. Welding bases have been included at the edges for holding the railings so no drilling is needed at site. The two units are placed 1 cm apart and a gutter underneath the resulting joint drains water away. Sealing the slabs is unnecessary. The support for the patio slabs forms a sandwich wall so no costly partitioning units (like iso-cages) have to be used. The windowsill of the door to the patio goes as far as a small gutter integrated in the patio slabs. It is placed with this and is the only sealing work in the whole of the construction unit.

The prefabricated concrete roof features a large integrated gable window fitted at the factory, and is placed as a single unit with one large window.

The majority of the work is dry construction - concrete in liquid form is only used for the floor slab. No scaffolding is needed because the scaffold sleeves are already included in the floor slabs, on the inside of the wall. Following erection of the rising walls, the scaffold poles can be taken safely out of the concrete slab and inserted in the next floor slab on the truck. This saves time spent erecting a scaffolding structure for the building shell.

"Concrete is one of the most universal building materials today," said Mr Orth.

"It is made from natural materials which can be recycled at the end of the building's useful service life. In addition, concrete can be placed to form any shape, surface and color without the need to apply pressure or heat." he said.

"These are just some of concrete's unique properties which have made this development possible."

The house in Annweiler nearing completion - image courtesy of Lösch Systembauteile GmbH + Co.

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2003

September

12-13th	NZRMCA Annual Conference 2003, Napier
Fri 16th	PCNZ Council Meeting Christchurch

October

3-5th	NZCS Conference, Wairakei

November

Tues 11th (revised)	CCANZ Board Meeting Wellington (AGM)
Wed 12th (revised)	NZRMCA Council Meeting Wellington

2004

September

16-19th	Combined Concrete Industry Conference, Queenstown.

PCNZ Annual General Meeting — PCNZ

The AGM of Precast NZ Inc will be held at 3pm, 28 August 2003 at the Hotel Grand Chancellor, in Mangere. Peter Degerholm, Chief Executive Officer of the NZ Building Subcontractors Federation is guest speaker and he will discuss the Construction Contracts Act and its effect on new contracts coming into the market place. Peter has been closely involved with the legislation, from overseeing the Bill through representations to select committees, until final enactment. His interest now lies in the analysis and interpretation of sub contracts for compliance with the Act. The AGM signals the start of an exciting year ahead for Precast NZ. Projects scheduled for this year include product standardisation (jointly with CCANZ), Stage 2 of Standard Bridge Beams with Transfund, guidance to members on contract administration, promotion to industry, input to NZS 3101 revision, and an upgraded website. The size of the project workload is an indication of the expanding industry interests of Precast NZ as it looks to the future and the interests of its members and associates.

Thanks to Ready Mixed Concrete Ltd — PCNZ

Precast NZ would like to thank Ready Mixed Concrete Ltd. for the use of its Greenlane meeting room over the past year. This has been a great venue - accessible for out-of-towners and providing full equipment support.

Construction Contracts Act 2002 — PCNZ

Precast NZ will shortly begin working with Peter Degerholm on a project analysing sub-contract agreements on a tabular clause-by-clause basis and providing recommendations for dealing with those clauses. It is intended that this will be published as a guide to members. A further project under consideration is the development of a special conditions document which could be substituted for the main contractor's special conditions when signing a sub-contract agreement. It is hoped that this document would also be able to be used as the standard conditions of quotation at time of tendering.

Canterbury University (Canterprise) Hollow Core Seating Project — PCNZ

The Technical Advisory Group met on 10 July to discuss the results of the PCNZ sponsored seating detailing testing. A report is now being prepared and will shortly be circulated to industry.

Dale Turkington presentation — PCNZ

The Executive committee was fortunate to have Dale Turkington as guest speaker at a recent Executive meeting. Dale is an experienced international engineer and is currently Commercial General Manager for Beca's Infrastructure Group. Dale gave a "no punches pulled" presentation on 'How Precast meets the Demands of the NZ Building Industry, from the perspective of an engineering consultant'.

Concrete Society Conference 3-5 October 2003 - get in quick! — NZCS

A reminder that early bird registration for the Concrete Society Conference closes Friday 5th September. After this, not only do you pay standard rates, but you may also miss out on accommodation at the conference venue Wairakei Resort. In recent years, this venue has been fully booked by conference attendees, with some late registrants having to travel to Taupo each evening for accommodation. So, get in quick! Interest in this year's conference is extremely high, given the excellent programme including keynote speaker Alan Burden. The conference begins midday Friday and is broken into three half day sessions, minimising time away from the office for delegates while providing ample time to meet and catch up with each other. An interesting and varied partners' programme is attracting increasing numbers of partners to each conference - so why not take a break with your partner? You'll both enjoy the ambience of the Wairakei Resort and earn CPD points at the same time. For more information or to register, visit the conference website at:
www.theconcreteconference.co.nz

NZCS Awards 2003 — NZCS

A record number of entries have been received for the 2003 Concrete Awards. Four new categories have been added to the Awards, which now recognise excellence in the use of concrete for Residential, Landscaping, Infrastructure, Technology and Architecture categories. All entries will be on display at the Concrete Society Conference at Wairakei, with the winners for all categories announced at the Awards Presentation Dinner on Saturday 4 October.

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