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Sydney Seminars Set Precedent for Other States

The National Precast Concrete Association Australia has teamed with the Concrete Institute of Australia, the Master Builders Association and the Royal Australian Institute of Architects to help promote its series of Precast Seminars which are being run around the country.

According to NPCAA Executive Officer Sarah Moore, the success of the first round of Seminars in Sydney have set the precedent for other States. Held in conjunction with Form and Function at Darling Harbour, the Seminars attracted well over 150 architects, engineers and builders.

"The popularity of the seminars is indicative of the current interest in precast as an alternative to traditional construction methods," said Ms Moore.

"Precast is revolutionising the industry, with more and more industry stakeholders recognising its cost-saving benefits. What's more, there are safety spin-offs from having a cleaner and less cluttered site. It is environmentally friendly, it performs well acoustically and thermally, and it is low maintenance. With precast you can expect a high quality product."

"These Precast Seminars will help architects, engineers and builders/developers to better understand the huge potential precast has to transform their businesses – making them more efficient and competitive. The seminars will provide a better understanding of its applications, capabilities and properties."

Following the Sydney Seminars, Seminars are also being held in Melbourne (29-30 May), Perth (20-21 July), Brisbane (22-23 August) and Adelaide (13-14 November).

For more information visit http://www.npcaa.com.au/html/EDUCATION.html

Safety was a focus for Girotto Precast NSW General Manager, Rob Power, at the Precast for Builders Seminar in Sydney.

The NPCAA stand at Form & Function generated considerable interest from visitors.

According to Peter Poulet, Acting Assistant NSW Government Architect, "Precast and systems technology are revolutionising the industry and point to an exciting future for architects and designers."

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Technical Basics No. 1 – Acoustic Properties of Precast – May '06

by Peter Knowland & Paul Uno

Acoustic Properties of Precast Concrete

In today's cities people are living closer and closer together primarily due to urban consolidation. The need to utilise services and infrastructure, to be close to work, and to be close to entertainment is of high priority.

Medium density living in modern architect-designed glass and concrete structures is very much in demand, and thus it becomes the task of the designer to ensure the building inhabitants have a comfortable living standard. Precast concrete structural walling and flooring systems are becoming an integral part of this construction process of multi-unit buildings. Knowledge of the acoustic properties of such forms of construction is crucial to ensure quality lifestyle living in these buildings.

Part of this process it to ensure that noise from people working and living above, below and outside of a dwelling, does not hinder one's lifestyle. Building designers need to understand the basic science of acoustics and noise control. The following information shows how precast concrete is not the problem, but rather, the solution when one is trying to limit noise intrusion.

Noise Levels & Measures

Noise values quoted in reports and technical datasheets most times will be a number approximately in the range of 40 to 100 with the letters dB after the number eg 70 dB. The dB stands for decibel (one tenth of a Bel) and is a logarithmic scale (similar to the Richter scale for earthquakes). Whilst noise levels can be outside this range, those values would tend to be in the extreme (eg values over 100 dB are extremely loud and often short in duration).

If however one sees values quoted in dB(A) then this scale relates to the sound measured in particular with its reference to the human ear. This scale has been "weighted" to correspond to the way the human ear hears sounds at corresponding loudness levels in each frequency. Road traffic noise levels are usually quoted in terms of dB(A) and the "difference" between outside and inside noise levels (due to barriers, windows, walls etc) is quoted as dB(A) reduction.

Sound Reduction Ratings – Wall & Floor Panels

Precast concrete floor and wall panels (as well as other materials eg glass) are tested both under laboratory conditions and on-site, to establish their acoustic ratings. This is basically to establish how efficient they are at reducing the transmission of noise from outside to inside environments. For example, measurements of noise levels taken near a busy highway and on the outside of a building wall may show that average noise levels are around 80 dB(A), yet when measured on the inside of that building only record 50 dB(A). The difference between the two levels is 30 dB(A), so an approximate noise reduction rating for that wall would be 30 dB(A).

Sound transmission loss of an acoustic barrier system was previously rated as Sound Transmission Class, a system derived from America. This system not only takes into account the difference between noise levels either side of a wall (or floor, or ceiling) but also the absorption capacity of the room itself eg a room lined with soft textured fabrics will record a lower noise level since many of the sound waves entering that room get absorbed by the soft materials. The formula that is normally quoted in this application is:

$$TL\ (dB) = L_1 - L_2 + 10 \log_{10} (S/A)$$

Where: $L_1 - L_2$ is the noise reduction or difference either side of the barrier (generally taken as internal)

S is the area of the dividing wall

A is the equivalent absorption area of the receiving room (determined from reverberation measurements).

In recent times the TL rating system has been changed to conform to the International Standards Organisation system of Weighted Sound Reduction Index Rw. This, in essence is similar to the previously used Sound Transmission Class system.

Both the rating systems and Sound Transmission Class were based on a speech related noise spectrum and in this regard are successful at determining required performance for the sound insulation required by a dividing barrier. In the case of the Sound Transmission Class, it's deficiency in the low frequency area was identified and there was an attempt to introduce Music Transmission Class to take this into account. In the case of the ISO Rw system it was recognised that it did not adequately insulate against external traffic noise and the correction factor Ctr was introduced to provide enhanced low frequency sound insulation. Work done in the United Kingdom showed that using the Ctr factor also provided more appropriate sound insulation when dealing with modern home entertainment systems. The Ctr correction factor has been introduced into the Acoustic Provisions of the Building Code of Australia since 2004.

The Precast Concrete Handbook gives values for various common concrete wall arrangements (see Tables 1 and 2 – which are reproductions of Table 9.8 & Table 9.9 from the Precast Concrete Handbook-Sept 2002). Added to the Rw values are the spectrum adaptation terms Ctr.

When dealing with external noise intrusion, particularly traffic noise, there is a rule of thumb used in a number of Australian Standards that the effective dB(A) reduction equals the Rw rating minus 5. If the Ctr spectrum adaptation term is used the dB(A) reduction is likely to be closer to the Rw factored down by the Ctr rating.

In the case of external noise intrusion the external wall is usually a mixture of solid wall and windows and/or doors. The concrete panel has a typical Ctr value of -5 which is very good. If double glazed windows are used the Ctr value could be -10 for that component. It is therefore necessary to examine the composite sound transmission loss of the solid wall area together with all the components that make up that wall, in order to determine the Ctr value for the composite construction.

Performance of 150mm precast panels

A 150 mm thick precast concrete panel is an interesting situation in respect to compliance with the Building Code of Australia. The typical laboratory performance of a 150 thick precast wall is Rw 54 and the Ctr is -5 giving an overall rating of Rw + Ctr equalling 49 dB. Technically this does not comply with the BCA, which requires 50 dB and there has been experience with some certifiers that will not approve a 150 precast concrete wall as complying with the BCA 2004 onwards acoustic provisions.

This would be fine if people lived in acoustic laboratories, but they do not, they live in real apartments. There are some walls that perform well in an acoustic laboratory but do not perform well when installed. The acoustic laboratory has precise openings built to fine tolerances. This does not exist in the field.

There are other walls however that better accommodate site tolerances and experience has clearly demonstrated that precast panels lose very little performance between that tested in a laboratory and that measured in the field, assuming that the rest of the structure is up to the appropriate acoustic standard. What is more important is the field performance (designated as Dntw). The requirement of the current BCA is that the installed performance including Ctr should exceed 45 dB. In this regard the precast element easily achieves this value with a field result in the range Dntw + Ctr equals 47 to 48 dB.

The acoustic laboratory measurement is essential and is the first starting point in acoustic design, however it is the installed result in the finished apartment or town house that is vital and will become the dominant factor in the future. As previously said, people do not live in acoustic laboratories, they live in apartments and it is there where the acoustic performance must be delivered.

Effect of Fixing Plasterboard

Whilst a 150 thick precast concrete panel has a Ctr value of -5, this value is made more negative if a plasterboard wall on furring channels is fixed to the precast wall, giving a less favourable result overall. The thinner the furring channel and the lighter the plasterboard, the more the Ctr factor is made negative. This should be watched carefully. When dealing with internal noise and furring channels are applied to both sides of the precast wall together with the use of 10mm plasterboard the effect of the two cladding systems is compounded in respect to Ctr. If it is necessary to provide cladding with airspace for the running of services then it is important that the plasterboard is either 16mm or 13mm sound rated, that the furring channels are no less than 28mm deep and that effective insulation is applied to both cavities.

It can be seen from Table 1 that a 150 mm precast concrete panel (which weighs 360 kg/m2) would provide at least 50 dB reduction of sound levels from outside to inside when exposed to road or rail traffic (or factory noise – refer to the Handbook for more detailed information).

Another simple rule of thumb that can be applied to materials to calculate their approximate transmission loss is the 'mass law' equation:

$$TL = 20 \log_{10} (mf) - B$$

Where: TL = transmission loss (dB)
m = surface mass (kg/m^2)
f = frequency (Hz)
B = 48 dB (on average but can range from 45-53).

Table 1

Calculated Rw Values (dB) for some Common Concrete Walls[9.12]

Type of wall and thickness	Rw	C_{tr}	Rw + C_{tr}
125-mm Concrete Panel (300 kg/m^2)			
Plain off-form concrete	52	-4	48
10-mm PB screw-fixed to 28-mm furring, on one side	52	-5	47
As above + fibreglass insulation	59	-7	52
As above, but with acoustic clips to furring + 10-mm PB direct-fixed to other side	63	-8	55
12-mm wet-area PB screw-fixed to 28-mm furring with acoustic clips + paint finish, on one side	57	-7	50
As above, but with ceramic tiles instead of paint	61	-7	54
150-mm Concrete Panel (360 kg/m^2)			
Plain off-form concrete	54	-4	50
10-mm PB screw-fixed to 28-mm furring, on one side	55	-5	50
As above + fibreglass insulation	61	-8	53
As above, but with acoustic clips to furring + 10-mm PB direct-fixed to other side	64	-8	56
12-mm wet-area PB screw-fixed to 28-mm furring with acoustic clips + paint finish, on one side	59	-7	52
As above, but with ceramic tiles instead of paint	63	-8	55
175-mm Concrete Panel (420 kg/m^2)			
Plain off-form concrete	57	-5	52
10-mm PB screw-fixed to 28-mm furring, on one side	57	-5	52
As above + fibreglass insulation	62	-8	54
As above, but with acoustic clips to furring + 10-mm PB direct-fixed to other side	65	-8	57
12-mm wet-area PB screw-fixed to 28-mm furring with acoustic clips + paint finish, on one side	61	-7	54
As above, but with ceramic tiles instead of paint	65	-8	57

Abbreviations :
PB = Plasterboard; FRC = Fibre reinforced cement formwork panel

Example: If one is interested in the TL value of a glass panel (density ~ 2700kg/m^3) with thickness 6 mm at a frequency of 500 Hz (ie this frequency corresponds to the C above middle C on a piano) then the m value would be 0.006 x 2700 = 16.2 kg/m^2, the mf value would be 16.2 x 500 = 8100 kg/m^2.Hz and thus the TL would be 30 dB.

Weak Links

Whilst the information above gives the designer a good reference point to start with when trying to account for noise levels in buildings, much of this noise reduction can be forfeited if the so-called 'weak links' are not understood and accounted for when designing a structure.

(a) Flanking

Noise entering a structure does not always follow a direct path from an outside noise source through the wall in question, to the person inside hearing the noise. Often the sound waves can enter from indirect paths such as through ceilings, service penetrations and joints. This being the case, a designer needs to reduce the noise levels from these flanking paths (eg providing separation materials between walls and/or ceilings; caulking perimeter walls –again refer to the Handbook for more detail).

(b) Openings, Holes & Cracks

Any concrete element will have its acoustic rating downgraded if openings, holes or cracks are left in the element after installation and during the life of the element. These openings provide an avenue for sound waves to penetrate directly through the panel. Figure I below (reproduced from an ABIC 1992 conference paper titled 'Acoustic & Thermal Advantages of Concrete' by Paul Uno) shows the reduction in sound level efficiency when openings of different sizes are present in panels. For example, if a panel has a sound transmission rating of 50 dB (when appropriately sealed) and an opening in that panel which only constitutes 0.01 % of the area of that panel (eg a 20mm diameter hole in a 2.4m x 1.2m panel), then the panel will now only have a 40 dB rating – well below most accepted ratings for building design

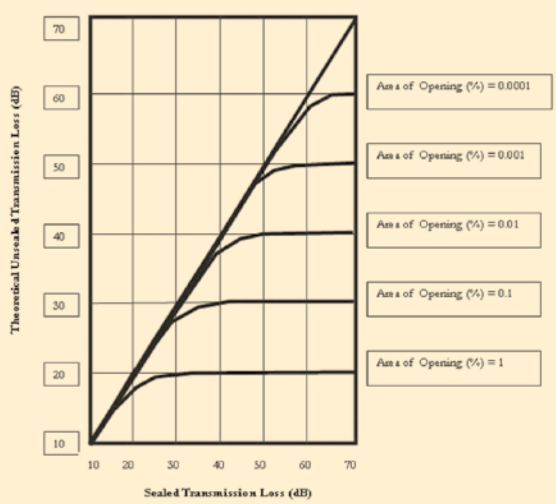
Table 2

Calculated Rw Values (dB) for some Common Concrete Floors[9.12]

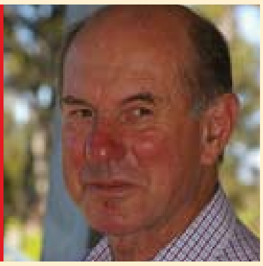
Type of floor system	Rw	C_{tr}	Rw + C_{tr}
150-mm Hollowcore Plank			
Plain untopped (220 kg/m^2)	48*		
With 60-mm topping (252 kg/m^2)	56	-4	52
With 60-mm topping + carpet on resilient layer + 60-mm air gap and 10-mm PB ceiling below	58	-6	52
200-mm Hollowcore Plank			
Plain untopped (278 kg/m^2)	50*		
With 60-mm topping (302 kg/m^2)	58	-5	53
With 60-mm topping + carpet on resilient layer + 60-mm air gap and 10-mm PB ceiling below	58	-6	52
250-mm Hollowcore Plank			
Plain untopped (312 kg/m^2)	51*		
With 60-mm topping (410 kg/m^2)	62	-6	56
With 60-mm topping + carpet on resilient layer + 60-mm air gap and 10-mm PB ceiling below	59	-6	53
Composite Prestressed Beams and Insitu Slab			
O/A depth 228 mm comprising, 98-mm insitu + 12-mm FRC + 105-mm air gap + 13-mm PB ceiling	57	-6	51
O/A depth 258 mm, as above with 135-mm air gap	59	-6	53
O/A depth 308 mm, as above with 185-mm air gap	60	-6	54
Solid Concrete Floors			
150-mm concrete slab (360 kg/m^2)	54	-4	50
200-mm concrete slab (480 kg/m^2)	59	-6	53

* Values from CPCI Design Manual[9.10]

Figure I
Insulation vs % Openings



Paul Uno
Managing Director of Cement & Concrete Services



Peter Knowland
Principal of the acoustic consulting firm PKA Acoustic Consulting

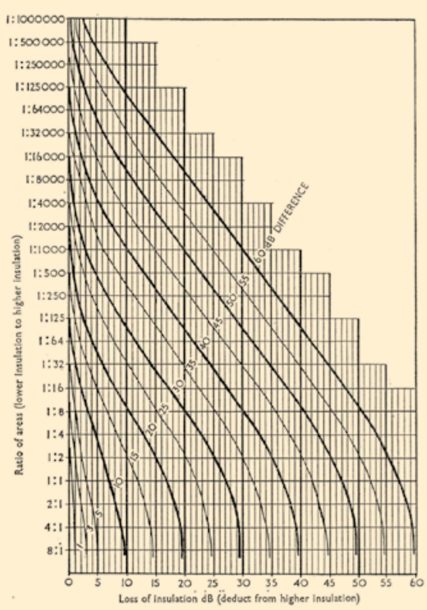
(c) Windows

Glazing is obviously a key part of any building envelope and as such the designer has to take into account the limitations of glass with respect to acoustic efficiency. The transmission loss of standard residential glass is around 25 dB and for 6mm commercial thickness glass it is around 30 dB. If one puts glazing into a precast concrete panel where the panel thickness is 150mm (TL = 50 dB) and the glazing is a single 6mm sheet (TL = 30 dB) then one cannot simply just average the two acoustic ratings as both values are logarithmic units. Whilst the mathematics is complicated for non-mathematicians, Chart A quantifies this 'composite grading' process.

From Chart A it can be seen that if the concrete panel is 6.0m x 2.4m and the glazing is 1.2 x 1.2m, then the ratio of the small panel to the large panel is (1.2 x 1.2 / 6.0 x 2.4 = 0.10 or 1: 10). The acoustic rating difference between panels is 20 dB so the 'loss of insulation' from the higher value is 9 dB which means the composite panel TL value is 41 dB.

If however, the panel contained a louvre panel for air-intake (which has no sound insulation) rather than the glass panel, then the sound level difference between the two panels would be 50 – 0 = 50 dB, and thus the composite partition TL value would be 10 dB (i.e. 50 dB minus 40 dB where the latter value corresponds to the x axis value from the chart for 50 dB difference and 1:10 ratio).

Chart A – Composite Walls Sound Insulation



Summary

In conclusion, when one is concerned about acoustic performance in building construction, precast concrete is seldom a concern as it has excellent sound transmission loss properties.

As well as performing well acoustically, aspects such as quality control, curing and crack elimination are issues which have been addressed during the manufacturing process.

This is sometimes not the case with concrete which is not factory-manufactured. For example, lack of vibration on site may result in incorrect element density, thus the mass of the panel is reduced leading to small TL (Rw) values. Cracks may occur due to lack of quality control on site (eg lack of curing, or incorrect protection procedures on site against adverse weather conditions), thus providing acoustic leakage paths and thus downgrading the overall sound rating of the building envelope.

Precast elements have very high sound transmission loss values (i.e sound reduction index values) and as such the designer needs to address the TL (Rw) values of other elements incorporated into the panel or building envelope to ensure the whole façade or envelope is not compromised by other elements with lower TL (Rw)values.

References:

(1) Precast Concrete Handbook, Sept 2002

(2) "Acoustic & Thermal Advantages of Concrete" by Paul Uno, ABIC Conference 1992 p67-69

(3) "Concrete in Energy Efficient Design & Noise Control" by Paul Uno, TN62, CCAA, 1993

(4) "Acoustics Noise & Buildings", Humphreys & Cowell

(5) Peter Knowland & Associates (Acoustic Consulting Engineers)

Precast from all Angles – A Team Effort
Marquet St, Rhodes NSW

One of the largest projects in Australia involving the use of precast in a multi-unit residential estate is currently being built in Marquet Street Rhodes, an inner western suburb of Sydney. The project is comprised of 11 buildings, some up to 7 storeys high and with spectacular view of Parramatta River. Some are medium rise 'typical rectangular cross-section' constructions whilst others are 'semi-circular' in cross-section. The project involves some 6000 units of precast concrete being manufactured off-site, then brought to site and erected quickly and safely. Balconies are one of the features of this project – obviously to capture the incredible view.

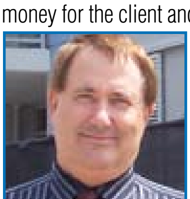
Noel Samyia

The Architect's Perspective

The architect for this project is Noel Samyia, Associate Director, PTW (previously known as Peddle Thorp Walker Architects). Although Noel has been an architect for many years, his experience with precast had primarily been with one-off precast elements… but nothing on this scale where virtually the whole structure was precast. Having now been involved with a successful precast project of this scale, he says the key to the success was to examine the shop drawings in detail – a rigorous disciplined approach and as a result *'everything went like clockwork'*.

With respect to the quality of work achieved by the precast manufacturers, he said "Even though we nominated Class 2 finish in the specification, the precaster virtually achieved Class 1 on nearly every panel. On site they were achieving rates of one floor per week with no wet trades and no formwork floor propping (when compared to conventional poured on-site floors)".

In conclusion Noel says "We felt it was value for money for the client and being very happy with the result we would be keen to do it again".



Chris Shipway

The Builder's Perspective

Baseline Constructions were engaged by the developer to convert a traditional in-situ designed residential project to a modular precast built form. The design constraints were to 'not compromise' the architectural integrity of the design and still comply with pre-sales agreements and development consents.

Baseline took control of the modular system redesign and coordination in its 'design and construct' role without any delay to the contract start date. Their modular systems are easily adaptable to any project and the benefits are to be realised in time savings, a quality finished project and cost savings.

According to Project Manager Chris Shipway, *"The major difference was that the site was cleaner and more efficient. It was good not seeing bricks and sand everywhere. The site had fewer workers, and these workers became crews designated to primary functions. The repetitive process of using precast floor to floor in a systematic fashion proved advantageous as the crews got a better knowledge of what to do 'quickly' on each floor. It became virtually just a 'panel on site erection process' rather than all the more complicated aspects of premixed concrete".*

Chris' final words were *"Having worked on this job, I am now convinced that precast is the way to go".*

The Precaster's Perspective

Two major precast manufacturers were involved in the supply and erection of precast panels for floors and walls, namely Hanson Precast for the flooring and lift-well shafts, and Girotto Precast for the walling.

Peter Webb

Precast Flooring Manufacturer

Hanson Precast's Marketing Manager Peter Webb, has seen precast become established as a mainstream building system over the many years of his involvement in this industry. The flooring and liftwell units for this project were manufactured at two of their facilities, with the hollowcore flooring coming from their Mulgrave factory, and the liftwell units being produced at their Riverstone factory (both located in the north-western regions of Sydney).

According to Peter, the reason for the success of the project was communication. *"Communication between all of the major players months in advance was crucial. The early decision to produce shop drawings gave us a fantastic opportunity to plan our production in a timely and cost effective manner".*

Hanson Precast produced 3500 hollowcore floor panels ranging from 150 mm deep to 300 mm deep (a total area of 23,000 m2). Each panel was produced with a ± 3mm tolerance on thickness and strand location. The 28-day strength of these panels was a minimum 40 MPa. No supplementary cementitious materials (eg flyash or slag) were used in the production of the panels. Topping concrete was 32 MPa.

In addition to the flooring panels, they also supplied over 570 Transfloor panels (ie nearly 7000 m2) for balconies on this project. Due to the picturesque views of water from this Rhodes site, balconies were a key feature of

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Precast from all Angles – A Team Effort

Marquet St, Rhodes NSW

the design layout. These flooring panels are usually cast as a 75mm thick roughened slab with triangular shaped reinforcement already cast into the panel. An upturned beam at the edge, usually around 265mm high, forms the spandrel beam upon which balcony railing is provided (usually glazing). In-situ concrete (32 MPa grade) is then poured over the floor units to form a 'composite' action with the precast. The off-form finish of these panels is a Class 2 finish (i.e. a view which, in the words of the Formwork Code AS3610, would be 'subject to close scrutiny… where it can be repetitively achieved over large areas').

Robert Power

Precast Walling Manufacturer

All the precast walls were manufactured by Girotto Precast at their factory in Prestons, near Liverpool in New South Wales. According to Robert Power, General Manager of Girotto Precast's NSW business, *"it is hoped that this project would be the yardstick by which other similar projects would be judged and that once complete should convince other developers and builders of the merit of using precast on these multi-level, multi-unit developments".*

The internal and external wall panels were 150mm thick and 180mm thick respectively. Panels had to satisfy a minimum 40 MPa compressive strength at 28 days. A high early strength Portland cement (in accordance with the cement code AS3972) was used but no supplementary cementitious materials (such as flyash or slag) were added. All external panels had shiplap joints (to prevent water ingress from outside).

Girotto Precast produced over 1600 wall panels with internal panels measuring 2.81m wide x 10m long and external panels measuring 3.10m wide x 10m long (both around 10 tonne in weight). All panels contained one layer of mesh, SL92 for the internal walls and RL918 for external wall panels. Craneage was strategically positioned to lift the large precast concrete panels into their final position on the structure.

Discussion and initial detailing on this project started at least 5 to 6 months before production commenced. We all worked well together (referring to the architect, the builder, the engineer and the other contractors) discussing all aspects of this job well before even one panel was produced. Finally when panels were produced they remained in our factory under cover until required on site – panel quality being the essence of good precast", Robert Power said.

Rod Wong

The Structural Engineer's Perspective

The structural engineers for this project are Meinhardt & Partners and the main engineer heading this project is Rod Wong (Associate Director). According to Rod, *"there were initially three possible building systems being considered – (1) post-tensioned, (2) in-situ and (3) precast - the system eventually chosen being precast. In the end the client (Statewide) and the managers for the client (Integrated Project Services) achieved a significant time saving and competitive advantage by using precast concrete as the primary construction unit".*

Meinhardt supplied the design live loads and specified the reinforcement for loadbearing walls. A key 'engineering' achievement of this project included the long span balconies. The two way span of some of the balconies of this project was around 3m (a large span using any building system). This span was even more of a challenge considering individual precast units had to achieve this objective.

According to Rod, the solution came in the form of Transfloor - precast units usually 75mm thick with reinforcement projecting from the concrete and with a Class 2 form finish on the soffit. Rod and his team took this essentially one-way precast unit and used them in a way to achieve a two-way spanning 'composite floor', thereby satisfying both short and long term Code deflection requirements.

In summary, it can be said that good communication and a team effort and using precast concrete as the primarily building component was the essence of the success on this project. This then will obviously become the benchmark for all subsequent multi-unit medium to high rise projects.

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