NATIONAL PRECASTER

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www.npcaa.com.au

NPCAA cements relationship with exhibitions

The National Precast Concrete Association Australia (NPCAA) is the latest addition to Australia's largest exhibitions for the building and design industries, 'Designbuild' and 'Form & Function'.

According to the Association's Executive Officer Sarah Moore, the decision to come on board for the 2006 exhibitions was just as obvious as the decision to use precast. "It just made sense," says Moore. "As precast is increasingly becoming the number one choice for walling, flooring and structures, so too, we need to be associated with the leading exhibitions for the building and design industries."

"The market share of precast is increasing. Already many of the country's leading architects, designers, builders and engineers are choosing precast. We are excited about further spreading the precast word.

"A series of seminars and workshops will be run alongside the exhibition, for architects and designers, quantity surveyors, builders and engineers. Subjects will include, for example, getting started with precast, precast construction, safety, thermal and acoustic properties, environmental considerations, the possibilities of architectural precast, design considerations, walling and flooring systems and pricing methodologies. According to Moore, using precast has benefits for everyone.

"With traditional construction methods, time, cost and quality are all critical to a project's success, yet usually one of the three is sacrificed to varying degrees. Not with precast. Manufactured in purpose-built factories, precast is not dependent on weather and is quality tested. And with repetition comes economy of scale. Being manufactured off site, precast minimizes site clutter, which has obvious safety benefits. And fast erection times combined with minimal propping allow other trades to proceed much faster.

What's more, precast isn't just restricted to grey panels. Architecturally, the possibilities are endless. The moulds which can be created are only limited by the imagination. Precast offers an endless variety of shapes, finishes, colours, patterns and textures. Put simply, if you want time savings, cost savings and quality – choose precast."

Watch out for the NPCAA stand at Design Ex Form and Function in Sydney and Designbuild in Melbourne.

Precast Seminars and Workshops – 2006

Architects' Seminars, Builders' Seminars and Engineers' Workshops will be held in Sydney, Melbourne, Perth, Brisbane and Adelaide. *Refer to page 5 for dates and registration details.*

Architects' Seminars

- Getting started with precast – systems, scheduling, contracts;
- Acoustic, thermal and environmental issues;
- Applications, colours and finishes;
- Design methods.

Builders' Seminars

- Getting started with precast – systems, scheduling, pricing, contracts;
- Erection of precast (handling, bracing, propping, tolerances);
- Safety;
- Structures, walling and flooring systems.

Engineers' Workshops

- Design of precast for strength (columns and slab elements for flexure, transverse & longitudinal shear, prestressed precast element losses, strut & tie models);
- Designing in precast for serviceability (deflections, crack control, camber & hog, vibration & resonant frequencies, colour control);
- Connections, fixings and joints;
- Erection of precast (handling, bracing, propping, tolerances);
- Safety.

For more information go to the NPCAA website, www.npcaa.com.au or Cement & Concrete Services online registration at www.cementandconcrete.com

The success of the Engineers' Workshops in 2005 has prompted additional seminars for architects and builders in 2006.

CONCRETE INSTITUTE of AUSTRALIA

Precast Seminars and Workshops are supported by the Concrete Institute of Australia.

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Use of Hollowcore Flooring in Composite Steel – Concrete Construction: Part 2 – Design Considerations

Dr Dennis Lam, University of Leeds, UK
(Currently Royal Society Visiting Fellow, University of Wollongong, Australia)

Professor Brian Uy, University of Wollongong, Australia

Introduction

This article presents the design procedures for the use of precast hollowcore slabs in steel-concrete composite construction. The paper also summarises the recent and on-going work on the transfer of this knowledge into the Australian construction industry. Whilst it is common practice to use precast concrete planks in Australian building construction, the benefits of composite behaviour with steel beams have not yet been fully realised with these systems, (National Precast Concrete Association of Australia, 2003). The use of precast hollowcore slabs in steel composite construction has seen rapid growth in popularity since it was first developed in the 1990s. The main advantages of this form of construction are that precast hollowcore slabs can span up to 15 metres without propping. The erection of 1.2 metre wide precast concrete units is simple and quick, shear studs can be pre-welded on beams before delivery to site thereby offering the savings associated with shorter construction times.

Summary of design considerations

- Generally a maximum of 250mm deep units, including any topping is used although tests have been conducted up to 300mm deep units. Full scale tests on 400mm deep units are planned.
- Shear connectors are generally 100mm x 19mm diameter headed studs. The use of other shear connectors are possible, but horizontal push tests Lam & Uy (2003) must be conducted to obtain the shear capacity of the shear connectors. For deeper units, 125mm height studs are recommended.
- The minimum effective width of approximately 1.05m (1.0 m + the gap between the units) of compression width for internal beams can be assumed in design, more accurately, the effective width can be calculated using the formula proposed by Lam (2005).
- The minimum beam flange width used in the UK is 140mm for construction purposes while a minimum beam flange width of 180mm is required for the Australian practice. (National Precast Concrete Association of Australia, 2003).
- The transverse reinforcement required for beam/unit interaction is recommended as N16 at 300mm centres to enable sufficient slip capacity for the shear connectors in partial interaction.
- The shear connector strength is related to the interaction of the concrete strength and properties, the geometry of the unit and transverse reinforcement.
- Research is currently being conducted at the University of Wollongong to consider the shear connection issues for typical Australian profiles.

Design procedures

Extensive research and design provisions have been carried out in the UK and this has resulted in the development of a joint industry (Precast Flooring Federation – Steel Construction Institute) design document being developed (Hicks and Lawson, 2003). This section presents the salient points relating to strength provisions in this document. Furthermore, suggestions on how these provisions may be used in light of Australian codes of practice are given herein:

1. Calculate effective width of hollowcore slabs:

Lam (2005) proposed the effective width for composite beam with precast panels as

(1)

$$b_{eff} = \frac{\sqrt{f_{ck,i}}}{35} \times \frac{32\phi_r}{500} \times \frac{f_{sd}}{460} \times 1000 + 2.5g$$

where

$f_{ck,i}$ is the in-situ infill concrete cylinder strength in MPa.

ϕ_r is the diameter of the transverse reinforcement in mm.

f_{sd} is the characteristic strength of the transverse reinforcement in N/mm^2.

g is the gap between the precast units in mm.

The effective width, b_{eff} of the concrete flange for positive bending in AS2327.1 – 2003 for a solid slab in a beam for a regular floor system is determined as the minimum of the following

(2)

$$b_{eff} = min.\left(\frac{L_{ef}}{4}, b, b_{sf} + 16D_c\right)$$

where, L_{ef} is the effective span, b is the spanning distance between consecutive beams, b_{sf} is the steel flange width and D_c is the concrete slab depth. The effective width determined from Equation 1 however can not exceed that determined from Equation 2.

2. Calculate the shear connectors' capacity:

The design shear resistance of an automatically welded headed stud with a normal weld collar using the Eurocode 4 (British Standards Institution, 1994) approach should be determined from:

(3)

$$P_{RD} = 0.8 f_u (\pi d^2 / 4)$$

or

(4)

$$P_{RD} = 0.29 \alpha \beta \varepsilon d^2 \sqrt{\omega f_{cp} E_{cp}}$$

whichever is smaller,

where

d = is the diameter of the shank of the stud;

f_u = is the specified ultimate tensile strength of the material of the stud but not greater than 500 N/mm^2;

α = 0.2[(h/d) + 1] for $3 \leq h/d \leq 4$ or

= 1.0 for h/d > 4;

β = a factor which takes into account the gap width g (mm) and is given as 0.5 (g/70 + 1) $\leq$ 1.0, and g $\geq$ 30 mm;

ε = a factor which takes into account the diameter ϕ of transverse high tensile tie steel (N500) and is given by 0.5 (ϕ /20 + 1) $\leq$ 1.0, and f $\geq$ 8 mm;

ω = transverse joint factor = 0.5(w/600 +1), w = width of hollowcore unit

f_{cp} = average concrete cylinder strength of the in-situ and precast concrete in MPa;

E_{cp} = average value of elastic modulus of the in-situ and precast concrete.

Thus, expressions for the shear capacity for an individual shear stud used in Australian construction (Standards Australia, 2003) could be augmented to account for the reductions in capacity experienced in hollowcore units and thus could be expressed as the lesser of f_{vs} in Equations 5 and 6 as outlined by Uy and Bradford (2005).

(5)

$$f_{vs} = 0.63 d_{bs}^{\ 2} f_{uc}$$

(6)

$$f_{vs} = 0.31 d_{bs}^{\ 2} \beta \varepsilon \sqrt{\omega f'_{cj} E_c}$$

where d_{bs} is the diameter of the shear stud, f_{uc} is the ultimate tensile strength of the stud, f'_{cj} and E_c is the mean concrete compressive strength and modulus at the time in question and β, ε and ω are parameters to account for the gap, tie steel and transverse joint respectively.

3. Calculating the moment capacity of composite beam:

For composite beams with precast hollowcore slabs, similar rigid plastic theory is applied. The only limitation applied for this form of construction is that the plastic neutral axis is below the steel – concrete interface. Figure 1 shows the plastic stress distributions under sagging bending with full shear connection.

The moment resistance of the composite sections where neutral axis is within the web is given below:

(7)

$$M_{pl,Rd} = M_{pl,a} + N_{c,f}\frac{(D + D_{slab})}{2} - \frac{D}{4}\left(\frac{N_{c,f}^2}{N_{a,w}}\right)$$

Where

$M_{pl,a}$ is the moment resistance of the steel section

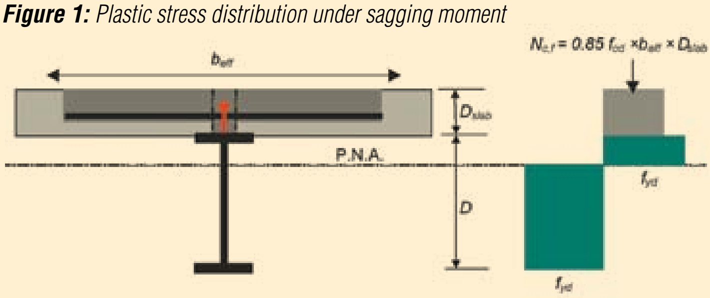
D is the steel section depth

D_{slab} is the concrete slab depth

$N_{c,f}$ is the compressive resistance of the concrete flange

$N_{a,w}$ is the resistance of the web of the steel section

Figure 1: *Plastic stress distribution under sagging moment*



Conclusions:

This article has presented the status quo for the use of hollowcore flooring in composite steel – concrete construction. Design provisions for strength have been presented as they appear in existing UK pseudo codes of practice. Research is on-going to provide for the transfer of knowledge from the UK to Australia taking account of the subtleties that exist in relation to hollowcore manufacture between the two nations.

References:

British Standards Institution (1994)
BS EN1994-1-1: Eurocode 4, 'Design of Composite Steel and Concrete Structures: Part 1.1: General rules and rules for buildings', London.

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'Design Guide to Composite Beams using Precast Concrete Slabs', Steel Construction Institute, UK.

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'Advances in Steel Composite Construction in the UK', Second International Symposium on Worldwide Codified Design and Technology in Steel Structures, Hong Kong, pp. 135 – 144.

Lam, D. & Uy, B. (2003)
'Recent Research and Development in Composite Steel Beams with Precast Hollow Core Slabs', Journal of Australian Institute of Steel Construction, Vol. 37 (2), pp. 1 – 13.

National Precast Concrete Association Australia (2003) Hollowcore flooring: technical manual.

Standards Australia (2003)
AS2327.1 – 2003, Composite structures – Part 1: Simply supported beams, Standards Australia.

Uy, B. and Bradford, M.A. (2005)
'Composite behaviour of precast concrete slabs with structural steel beams', *Australasian Structural Engineering Conference, Newcastle, September*, Full paper on CD-ROM, ISBN 1 877040 37 1.

Australian Centre for Life Long Learning

Project Details

Project name:	Australian Centre for Life Long Learning (ACLLL) Springfield
Principal:	Springfield Land Corporation & James Fielding Developments
Operator:	University of Southern Queensland
Head Contractor:	Baulderstone Hornibrook
Architects:	PDT
Structural Engineers:	Robert Bird and Partners
Precast Supplier:	Precast Concrete Products Pty Ltd

The soon to be completed ACLLL building at Springfield is another testimony to the success of early collaboration between the building designers, the builder and the precaster. Early in the design stage the decision was made to utilise a totally precast structure incorporating a range of factory applied architectural finishes. Before the building was put out to tender the precaster was invited to provide input on both the structural design and the range of architectural finishes available. As a result, as soon as the head contract was let the design documentation was advanced far enough to allow the precast package to be let and the precaster was able to start the project at the same time as the builder started on site. This was critical to the success of the project as the builder only had to level and prepare the site, pour the footings then start erection of the precast frame. The site went from a levelled block to a completed 6 storey structure in a matter of weeks (not months as would be common with more traditional construction methods). Of equal benefit to the builder as the reduced time, the site workforce for the building structure was drastically reduced and consisted primarily of a precast erection crew, form worker to place the metal deck floor system and a concreting crew to pour the floors.

The six storey building consists of a totally precast external structure. The two long sides of the rectangular building contained 500 x 900 precast columns at 10m centres with 200mm thick spandrels spanning between the columns. The erection sequence consisted of standing and bracing the columns then sliding the spandrel panels into pre-formed slots in the top of the columns. The metal decking was then placed, slab poured into starter bars cast in the spandrels and the sequence repeated for the next level.

The two end walls contained precast wall panels which had dowelled and grouted horizontal joints and starter bar connections to the slabs.

The wall and spandrel panels were split typically 1m above the floor levels to provide the builder with a safe working perimeter without the need for any additional handrails.

The architectural finishes included high quality off form dark coloured columns and acid etched spandrels and wall panels. In addition a series of heavy grooves and corrugated mould liners added expression to the façade. As the finishes were applied under factory conditions prior to delivery the quality of finish was even and consistent and there was no requirement for scaffolding to the precast façade on site.

2006 Precast Seminars & Workshops

CITY	VENUE	ARCHITECTS $99	BUILDERS $99	ENGINEERS $395
SYDNEY	Form & Function Sydney Convention & Exhibition Centre	Thur 6 April 2006 (10am – 12.45pm)	Thur 6 April 2006 (2pm – 4.45pm)	Fri 7 April 2006 (10am – 5.30pm)
MELBOURNE	Designbuild Melbourne Exhibition Centre	Tue 30 May 2006 (10am – 12.45pm)	Tue 30 May 2006 (2pm – 4.45pm)	Wed 31 May 2006 (10am – 5.30pm)
PERTH	Grand Chancellor Hotel	Thur 20 July 2006 (10am – 12.45pm)	Thur 20 July 2006 (2pm – 4.45pm)	Fri 21 July 2006 (10am – 5.30pm)
BRISBANE	Mercure Hotel	Tue 22 August 2006 (10am – 12.45pm)	Tue 22 August 2006 (2pm – 4.45pm)	Wed 23 August 2006 (10am – 5.30pm)
ADELAIDE	Hilton Hotel	Mon 13 Nov 2006 (10am – 12.45pm)	Mon 13 Nov 2006 (2pm – 4.45pm)	Tue 14 Nov 2006 (10am – 5.30pm)

REGISTRATION FOR NPCAA PRECAST SEMINARS & WORKSHOPS

Please return this form (together with credit card details or cheque payable to Cement & Concrete Services) to:
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C/ – Cement & Concrete Services
PO Box 913 Baulkham Hills NSW 1755 Ph (02) 9899 7447 Fax (02) 9899 5995 Mobile 0413 998 031

More information info@npcaa.com.au or info@cementandconcrete.com or www.npcaa.com.au or Cement & Concrete Services online at www.cementandconcrete.com

We wish to attend the NPCAA Precast Concrete Seminar and/or Workshop

As follows: (tick) Please indicate Sydney, Melbourne, Perth, Brisbane or Adelaide.

- Precast for Architects ☐ in ______________________
- Precast for Builders ☐ in ______________________
- Precast for Engineers ☐ in ______________________

	Number		
Architects' or Builders' Seminars	☐	@ $ 99 per person	$
Engineers' Workshops	☐	@ $ 395 per person	$

Text Recommended Precast Concrete Handbook (2002) – containing 400 pages of text, examples and photos.

	Number		
Precast Concrete Handbook	☐	@ $ 180.00	$

Total Payment (cheques payable to Cement & Concrete Services) – prices include GST $

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Expiry Date / ____________________ Signature ____________________

Cancellations made 5 working days or less days prior to the course will incur forfeiture of the registration fee.

Australian Standards & Codes Update

The NPCAA has had a long history of being involved with Standards Australia particularly as a representative body on Standards Committees. The main reason for the Association's strong involvement is to keep precast construction in the forefront of the regulatory process which flows through to the BCA and the myriad of Australian specifying authorities. It is also of particular importance to NPCAA members to be aware of upcoming changes that may have an effect on their industry and thus react accordingly for the benefit of all associated with precast concrete. Some information on Code changes is listed below.

BD2 – AS3600 Concrete Structures Code

Late last year the BD2 committee met to consider 645 public comments received on draft DR052. The nature of many of these submissions is such that various BD2 subcommittees will need to resolve a considerable number of issues before the main committee can meet again to finalise the code. It is envisaged that the final version of AS3600 will not be published until late 2006 or early 2007.

BD 32 – AS2327 Composite Structures

AS2327.1 sets down the requirements for design and construction of simply supported beams such as hollowcore planks acting compositely with steel beams.

This code Committee has been reconvened to extend its coverage to continuous beams, slabs and columns. Brian Mallon (NPCAA Technical Consultant) will represent the Concrete Institute of Australia and the interests of NPCAA on BD32.

BD 43 – AS3610 Formwork

It is unlikely this Standard will be released in finalised format before July 2006.

BD 84 – AS 4672 Prestressing Steel

The likely publication date for this Code will be around February or March 2006.

BD 80 – Building Facades

The likely publication date for this Code, AS/NZS 4284 – Testing of Building Facades, will be around March – April 2006.

Other Standards

Other Standards that the NPCAA are involved with include CE19 – Utility Service Poles, WS13 – Domestic Waste Water Management Services, BD49 – Manufacture of Concrete, BD66-Tiltup Construction, and CE26 – Precast Reinforced Box Culverts.

Even though the The Precast Concrete Handbook is not an Australian Standard it is regarded by many in the architectural and engineering fraternity as a "standard" or pre-eminent guide on precast construction. In 2006 Brian Mallon, will be heading up a committee to publish the 2nd edition of the Handbook by early 2007 and any comments (errors, omissions etc) from the readers of the Precaster would be welcome.

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