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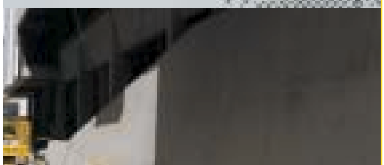

TIPS

CEMENT CONCRETE & AGGREGATES AUSTRALIA

Leading Knowledge-Sharing Information

Refer to www.concrete.net.au for information on:
Exposed Aggregate Finishes for Flatwork;
Herzog de Meuron, Mix 5 April 2000;
Mixtips, Mix 15 July 2004.

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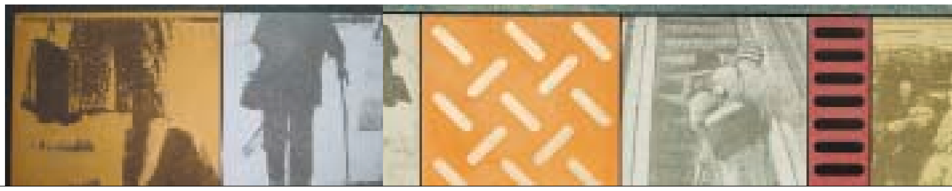
Extracting an Archive in Concrete

Public Art Projects, Perth Western Australia

Two public art projects which have recently been completed in metropolitan Perth, use experimental photo etching techniques to create crisp imagery in concrete. The works, designed and fabricated by Concreto, comprise a paved entry apron to the City of Stirling Civic Building Complex and a long wall panel for the Clarkson Transit Railway Station. Concrete was selected for its robust long-term performance in urban sites, and the process of photo etching provided a means to respond directly to the interpretative requirements of each project.

At Stirling, the entry paving which is featured above, was required to narrate something of the city's history to its constituents. Council archives provided a wealth of interesting singular images which were selected for the base artwork. To highlight the process of history as a 'structuring device', individual images were edited as a series of nine 300-mm wide film strips (a total of 30 metres) and laid at the foot of the building entry. By contrast, the Clarkson wall art project comprises 44 500 x 500-mm tiles which run the length of the station entrance. The 14 photo etched panels offer snapshots of commuters and contrast to the more graphic elements of the project.

The distinct pictorial style of each project derives from the digital manipulation of base imagery. For the Stirling project, archival images were abstracted to a halftone 'news print' dot matrix; at Clarkson, the structural 'grain' of the photographic medium was enlarged. The final artwork was copied to clear film (at actual size) to produce a transparent positive image, which was



CLARKSON TRANSIT RAILWAY STATION WALL PANELS

CITY OF STIRLING CIVIC BUILDING PAVING PANELS

then transposed to a light-sensitive emulsion on a silkscreen and exposed to ultra violet light. The positive areas of the screen block out light and were washed-away after exposure. The resultant open screen was used to apply the image onto a waterproof polypropylene sheet form liner using a liquid solvent-based cement retarder.

Panels were cast face-down with the printed form liner at the base of a steel mould [1]. A thin layer of cement-rich product with contrasting aggregate was poured to cover the form liner at a depth of 10mm and after a period of three hours was backed with a reinforced structural concrete mix to a total depth of 50mm to form a monolithic bond.

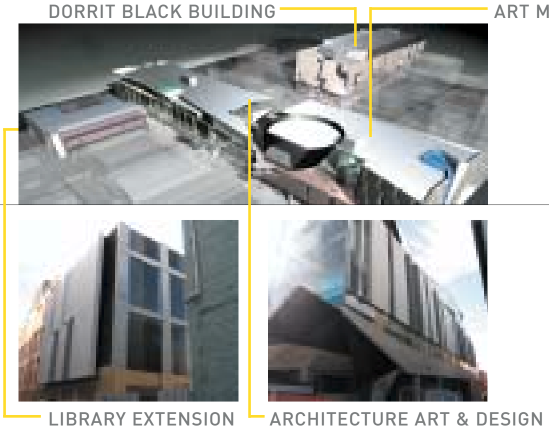
The retardant inhibits the setting time of the concrete surface in contact with the printed areas [2]. After a period of 24 to 48 hours, the cement paste in contact with the retarder was washed out, revealing the underlying aggregate in contrast with the off-form unprinted surface of the polypropylene sheet [3].

Retarders vary in strength and plasticity. Working out which concrete mix works best with which retarder is a matter of trial and error. For these projects, Concreto imported a product from Pieri in France, which prints well and does not bleed during the concrete pour. The depth of etching is less aggressive and allows for fine image resolution. Other retarders are suitable for bold designs with deep etching between 5 to 10mm, but will also result in definition loss due to a greater proportion of cement paste being removed.

The high contrast between the cement matrix and aggregates was achieved using a small 2 to 3-mm granite stone with a black granite dust. For the Clarkson project oxides were added at a 5% by weight ratio to the cement to add further dimension and visual contrast to the surface.

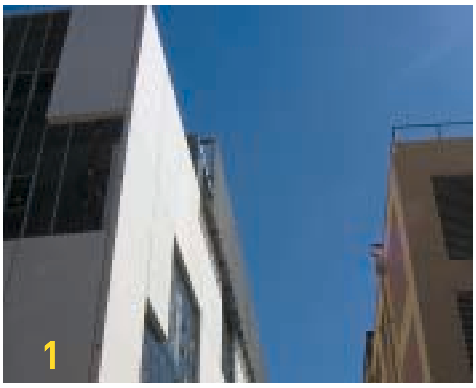
Photo etching into concrete produces permanently engraved surface relief. While the process has been used extensively in applied art, it is relatively untested in residential and commercial applications. Concreto is currently investigating the transposition of the technique to large precast panels.

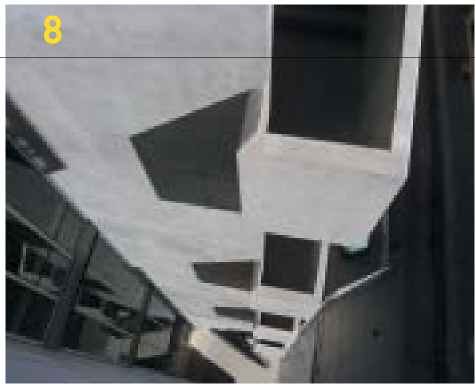
City of Stirling Paving Art Project
(Building by James Coulter Young)
CONCRETE FABRICATOR: Concreto
COMPLETION: March 2005
LANDSCAPE ARCHITECT: Arbor Vitae
ARTISTS: Margaret Dillon, Penny Bovell
Clarkson Transit Station Wall Art
(Building by Woodhead International)
CONCRETE FABRICATOR: Concreto
COMPLETION: March 2005
ARTIST: Margaret Dillon
ARTICLE/PHOTOGRAPHY: Concreto



Stage 2 Works at the University of So

Enclosure/Exposure Using Precast Concrete Pane





Over the last decade or so, the tertiary education sector has actively supported new architectural commissions on campuses throughout the country. In contrast to traditional university towns such as Oxford or Cambridge, Australian city-based campuses rarely develop in the comfort of physical isolation. Rather, institutions such as RMIT in Melbourne and the University of South Australia in Adelaide, are encouraged to take quantum leaps in order to consolidate their urban footholds.

The Uni of SA City West campus was established in 1992 and the first stage of works provided 40,000m² of floor space built in a single construction program. The original campus masterplan comprised a layer of 4-5 level concrete frame and infill structures, which were built to a uniform height datum between North Terrace and Hindley Street, and riven by narrow secondary streets to connect the campus to the adjacent city centre.

Within this context, a major second phase of campus development is currently being undertaken by Wardle + Hassell Architects in Association. The works comprise 20,000m² of new floor space which is allocated in four buildings. Precast concrete construction has been selected for its low maintenance and integral-colouring, while various strategies have been developed to customise the application to meet the individual requirements of each building.

The Dorrit Black Building shown above, is located at the end of the main east-west campus walkway. It is five storeys high and incorporates a concrete plinth which is modulated and ramped to reveal the interior and provide disability access. Upper level circulation is arranged about two longitudinal corridors with open stairs at either end.

The building will accommodate the school's applied art teaching programme and requires large naturally-lit studio spaces. While the existing site constraints precluded the use of south-facing glazing, 3-dimensional solar modelling showed that the north facade is shaded by an existing building opposite.

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THE DORRIT BLACK BUILDING 1 EAST-WEST CAMPUS WALKWAY 2 STAIR 3 VOID 4 SOFFIT 5 MASS 6 LIGHT 7 SHADE 8 LANDING 9 SOLID 10 PLINTH 11 STREET CONTEXT 12 CONCRETE

This fundamental conflict in the functional brief was resolved by locating studios to the north side of the building and developing an innovative wall of precast panels which are literally left-off where internal daylighting is required. 'Solid' sections of wall enclose kiln rooms, darkrooms and the like; while glazed 'voids' replace whole panels to expose the studios to light. The resulting composition of solid and void contrasts to the monolithic quality of the original buildings and contributes to a new level of 'openness' within the campus.

All concrete structure is exposed internally including the ceiling soffits and floor slabs, which are sealed with a clear polyurethane coating. The plain grey insitu finish of the building plinth and structure contrasts with the Class 2 smooth white precast panels which are 170mm thick, 2m wide and between 5-8m high. The precast mix utilises quartzite aggregate and *Britonlite* cement, with 8% pure bright mineral oxide added by weight. Panels were coated off-site with a 2-component hydrophilic acrylic coating to protect against graffiti and minimise long-term staining.

Ultimately, the means taken to achieve the functional brief have resulted in a rigorous organisation of precast panels, which simultaneously 'randomise' the composition of the façade. The building appears as a massive rectangular solid with large sections removed; a fissured effect which is emphasised by the 350-mm thick return edges of the precast to the inner 'skin' of glazing.

Following on from previous institutional projects designed by the architects (see the 'cookie-cutter' CSIRO Lab by John Wardle Architects featured in Mix Vol 2), the Dorrit Black building at Uni of SA articulates an innovative application of precast concrete construction.

ARCHITECT: Wardle + Hassell Architects in Association
COMPLETION: Buildings nearing completion are the Louis Laybourne School of Architecture and Design, South Australian School of Art, Campus Library Extension; Due for completion in 2007 is the University Art Museum and Gallery, Chancellery and Hawke Centre
CONTRACTOR: Built Environs
PRECAST SUPPLIER: Marble & Cement Work Co. Pty Ltd
ARTICLE/PHOTOGRAPHY: Meaghan Dwyer/John Wardle Architects

Striking Formwork

Introduction

In its liquid state, concrete allows almost unlimited possibilities to mould its boundary to a final hardened shape. Since the structural strength of concrete derives from its cross-sectional area, the shape of cast concrete is ultimately limited by the formwork which stabilises it.

In the first instance, the selected formwork will effectively address the construction budget, building structure, location, site access, ease of handling, OH&S concerns and the management of waste. This guideline outlines some of the more specific opportunities and constraints which are associated with standard formwork systems.

Formwork

The surface finish and appearance of concrete is a direct reflection of the formwork used and its quality. As the required number of formwork re-use increases, the durability of the form-face or liner must likewise, increase. The requirements for good off-form surfaces are outlined in *AS3610-1995 Formwork for Concrete* and imply that adherence to quality materials and consistent work practices are crucial. With regard to the selection of formwork, liners and moulds, this includes the provision of rigid and mortar-tight forms, consistent scheduling for striking formwork, and rigorous maintenance of the formwork material.

Under AS3610, Class 1 concrete off-form surfaces are limited to small elements that can be formed with a single pour. Class 1 finishes are not permitted for surfaces formed with trafficable formwork, or where form liners are used, or where the entire surface receives a subsequent treatment such as acid etching or abrasive blasting.

Release Agents

The function of a release agent is to effect a clean release of the formwork from the concrete. The selected release agent must be compatible with the formwork and in architectural applications, it should assist in the production of stain-free surfaces and the reduction of blowholes, while not preventing the adhesion of a later-applied surface finish.

The application of release agents should comply with the manufacturer's recommendations. Ineffective coatings may lead to scabbing or scaling of the concrete surface. Conversely, excessive coatings may increase the number of blowholes and staining, or in some cases, lead to surface retardation.

The generic types of release agents which are outlined below include: neat oils with the addition of a surfactant (a wetting or surface activating agent); cream emulsions (water-in-oil emulsions with a surfactant); chemical release agents (low viscosity oil distillate in which small amounts of chemical are suspended); liquid waxes and pastes.

TABLE SHOWING TYPICAL FORMWORK SYSTEMS AND SUITABLE RELEASE AGENTS

Generic System	Formwork Material	Concrete Application	Absorption Behaviour	Suitable Release Agent	Typical number of re-uses
Timber	Rough/sawn boards smooth/dressed boards (Oregon)	Fair-face concrete with special requirements for exposed faces	Absorbent	Liquid wax, neat oil with surfactant, paste (not suitable for textured finishes)	up to 10
	Synthetic resin-bonded plywood board	Smooth concrete with special requirements for exposed faces	Absorbent	Liquid wax, neat oil with surfactant, paste	up to 30
	Factory applied plastic or plastic laminated plywood	Smooth concrete with special requirements for exposed faces	Not absorbent	Liquid wax, paste	80-100
Rubber	Polyurethane elastomeric moulds/ polypropylene silicone rubber	Modelled fair-face concrete with special requirements for exposed faces	Not absorbent	Cream emulsion, chemical release agent (check for adverse reaction of form liner with petroleum based oil emulsions and chemically aromatic substances)	up to 50
Plastic	Glass fibre reinforced plastics	Textured concrete with special requirements for exposed faces	Not absorbent	Cream emulsion, chemical release agent	80-100
	Rigid expanded polystyrene foam	Textured concrete with special requirements for exposed faces	Not absorbent	Cream emulsion, chemical release agent	1 - 5
Metal	Steel sheet	Concrete with special requirements for exposed faces	Not absorbent	Neat oil with surfactant, cream emulsion, reactive chemical release agent (a rust inhibitor may be necessary)	500+

Perret's Off-Form Technique

No sooner had the technique of cast concrete been perfected, that the authenticity of the process was questioned. To Auguste Perret, the building technology promoted mass-production using unskilled labour in unlimited quantities, and could not be scrutinised too closely.[1]

In his design for Le Raincy Notre Dame in 1922 for instance, not only was the formwork made by craftsmen, but its dimensional tolerance was measured to within three decimal places (i.e. the nearest millimetre).[2] Perret's insistence is baffling, given that later he would object to the off-form cement surface, which masked the essential quality of concrete underneath, and was systematically hammered-off to expose it. Technically, Perret was not trained as an engineer, although such an obsession suggests that pure technique is a road travelled by the lone virtuoso.

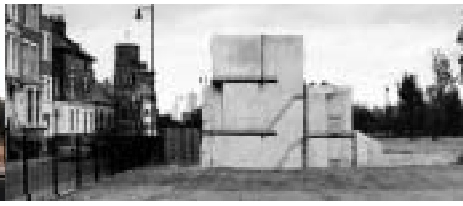
By contrast, to Kazuo Shinohara, technique was foremost a means to an end. Working in the Japanese tradition, Shinohara stressed that each architectural problem is not solved by technical means.[3] His Uehara House for instance, incorporates massive off-form trusses which deliver a productive tension between space, mass, material and technique. They are statically indeterminate spatial props which are mimetic of both a casting object and an object cast.

Working in the opposite direction, in 1993 the British artist Rachel Whiteread used a condemned Victorian London terrace as the insitu formwork to cast her mammoth sculpture 'House'. The entire interior was sprayed with concrete and then the timber carapace demolished to reveal a lifesize negative of the former dwelling, now turned inside-out.[4]

Whiteread's project reworked the paradoxical boundary of cast concrete and answered Perret's concern for a non-repeatable beginning and end.

PERRET 1922

SHINOHARA 1976



WHITEREAD 1993

Constructional Design Advantages	Material Constraints
Cost effective formwork for insitu work allowing 3-dimensional modelling of the cross-sectional mass	Significant surface variations may occur due to absorbency and/or porosity of the timber board; Curved or warped sheathing must be knot free
Cost-effective formwork for insitu and flatwork; Low relief surface modelling achievable by fixing negative components to the form face	Standard sheet sizes (2.4 x 1.2 m) may restrict surface articulation to modular compositions; Plywood for Class 2 - 5 concrete should be lightly sanded and pre-primed with the selected release agent to decrease absorbency, improve colour uniformity and maximise re-use of forms; Plantation pine ply is unsuitable for Class 2 finishes
Glass like finishes are achievable	Dense grain of form-face may initiate surface crazing, a high incidence of bug holes and non-uniform colour and should be lightly sanded/pre-primed before use
High flexibility, elasticity and durability of quality liners allow for high repeat precast and insitu use; Large panel areas are possible (up to 1 x 10 m); Customised deep articulated surfaces are achievable; Higher pour rates are generally achievable; Liners which are factory-bonded to plywood backings restrict liner growth/shrinkage and help to reduce on-site labour costs	Variations in physical dimension due to temperature; Deeply profiled liners (>30mm depth) require substantial force to strike the form from the concrete; Damaged liners are difficult to repair; On-site protection required against aggressive weathering and UV light; Deflection of the form can result from applied loads, concrete shrinkage and creep
High relief designs and complex shaping can be reproduced successfully and cost effectively	Formwork requires reinforcement to achieve desired stiffness
Lightweight moulds for voids and high relief surfaces; Class 2 finishes achievable with high-grade styrene	Low pour rates are generally required; Standard blocks cut from 5 x 1 x 0.6-m thick sheets
High-repeat smooth-faced concrete is possible	Minimum 6-mm sheet thickness required for repeat use and to prevent deflection of the mould; Rust removal may be required prior to each use

PERRET FOOTNOTES

1. Peter Collins. *Concrete, The Vision of a New Architecture.* McGill-Queens Uni Press. 2004 p. 342
2. Ibid. p.343
3. *Transition.* Vol 3 No.2 1983. p.9
4. See *Rachael Whiteread.* National Galleries of Scotland and Serpentine Gallery, London 2001.

AUSTRALIAN STANDARDS

Under AS3610, the completion of site test panels 14 days prior to construction is mandatory for Class 1 and 2 finishes. Test panels should replicate all aspects of the design including the specified form face, the specified release agent and the designated method of application.

FURTHER REFERENCES

CCAA Technical Data Sheets for concrete formwork include:
Briefing Note 3: Colour and Texture in Concrete Walling;
Briefing Note 6: Form Liners Achieving Surface and Texture;
See also Mix Volume 3 (1999)

ARTICLE: Gina Levenspiel
ACKNOWLEDGEMENTS:
Samia Guirguis, Adele Brooks;
Concrete Construction Manual, Birkhauser Edition Detail, 2004;
Concrete Architecture Design & Construction. Burkhard Fröhlich. Birkhauser 2002

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TIPS

Exposed Concrete Topping Slabs

Recent works at the Mint site in Macquarie Street Sydney, comprise the refurbishment of the historic nineteenth century building, a new head office for the Historic Houses Trust of NSW (incorporating a library, theatrette, reception and lobby areas) and the construction of landscaped courtyards. Exposed concrete is the principal internal and external floor finish and it is prevalent at all public entries, thoroughfares and amenities.

The design benefits of exposed concrete floors are discussed in the CCAA's Briefing Note 9 Passive Solar Design and Briefing Note 5 Polished Concrete Floors

Generally, the internal concrete floors comprise 50-mm thick decorative topping slabs with a layer of SL52 mesh laid with 20mm cover. 3-mm stainless steel angles were used to construct crack control joints and were screw-fixed to the base concrete, and packed to suit falls as required. The toppings were bonded to the debris-free concrete substrate with a two-part, solvent-free epoxy resin-bonding agent. 32MPa mixes were used for internal toppings with an exposed finish and incorporate 10-mm Peats Ridge basalt aggregate. External plinths and landings in the courtyard use 8-mm river quartz with a stone beige oxide (4% by weight). The topping mix contained a shrinkage-reducing admixture which was finished by machine trowel to produce a dense, uniform surface that would grind to reveal an even exposure of aggregates. By contrast, the library slab was laid full-depth with a 32MPa 10-mm mix, finished by machine trowel to a burnished finish producing a dense, highly-polished appearance. External plinths and landings were 150 to 300mm thick and hand-finished by steel trowel.

A water-based acrylic emulsion was used to spray-cure all concrete items after final trowelling. Generally after a minimum of 14 days, a rotary diamond grinder was used to hone the surface of exposed concrete to a depth of 3-5mm. Internal topping slabs were ground to a 400-grit fineness and sealed with a solvent-based penetrating sealer. External plinths were ground to a coarser 120-grit and sealed as above. The results of wet pendulum testing of each surface type confirmed a low to moderate risk of slipping in wet conditions. A 2 x 2-m sample was provided for the burnished finish in the library and three 1 x 1-m samples for the exposed topping mixes. The exposed and burnished finishes achieved at the Mint are fine examples of hard-wearing attractive concrete floors and external landings.

CONCRETE FABRICATOR: D. Raffin & Co. Pty Ltd
CONCRETE SUPPLIER: Boral Concrete
GRINDING & POLISHING: Vitric Quality Flooring Systems PL
ARTICLE/PHOTOGRAPHY: Tony Raffin
ARCHITECT: Francis-Jones, Morehen Thorp Pty Ltd
COMPLETION: August 2004