CONCRETE CONNECTIONS

Australasian Concrete Repair Association — Concrete Connection March 2017

In This Issue

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ACRA President's Message:

This is the first of this year's messages and the last few months of my tenure as President. I'm struck by the swiftness of last year and sometimes think that as a year finishes up what the next year will hold for us as an organisation.

There are events and seminars already ran to full houses and more planned as well as the end of year Trade Show in QLD. There are important ACRA/Australian Standards documents to be published and there was another successful ACRA Awards' Night held last year. Our congratulations goes out to those that won something on the night and to also those that contributed to a successful Awards' Night and those that put in some significant entries for the competition. I'd like to personally thank our judges Peter Reed, David Millar and Brian Seidler and a big thank you to Nicole for her tireless work in the running of this event and all the other State events, seminars and training courses too.

The year of the Rooster may turn out to be a feather duster for some (those born in 1969, 1981 or 1993) but for others, especially our Members I hope, it should be a year of full harvest time. They say people should have a relaxing or joyful time during the year of the Rooster while enjoying the fruits of the harvest. I don't know about you, but this Chinese astrologer is exhausted from the shenanigans of this past Monkey year! Surprise after surprise swung most of our ways during last year. Following 12 months of the wit and hyperactive Monkey, the **New Year of the Fire Rooster** is going to bring fresh challenges requiring quick wit and practical solutions.

So to all, good luck with the year ahead.

- Henk van den Heuvel

"Surprise after surprise swung most of our ways during last year"

- Henk van den Heuvel

Photo: Rehabilitation of deteriorated Seawall

Five Dock NSW

Marine and Civil Maintenance Pty Ltd

Be Prepared — Is Surface Preparation for Concrete Repairs a FAD?

Hamid Khan—Product Segment Manager—Parchem

When one is to commence concrete repairs, there are three most fundamental things; surface preparation, surface preparation and surface preparation. Strong and lasting bond between a repair material and the host concrete substrate is one of the crucial aspects of durability of concrete repairs. The potential performance of the repair can be completely undermined if the surface on which it is applied has not been properly prepared.

Repair Material to Concrete Substrate – An Alien or a Monolithic Bond:

In European standard (EN1504-10:2004), the term bond refers to the adhesion of the applied material or system to the concrete substrate. Hence, adhesion has an underlying importance in the repair of concrete structures. Surface preparation of the concrete substrate is considered to be the most crucial step in a concrete repair project. A poorly prepared surface will result in the weak association to the repair zone, no matter how proficient and expensive the repair material might be. The repair material when applied, should not act as 'an alien body' to the host concrete substrate, rather, it should become an integral part of the existing concrete restoring the structure to its original monolithic strength. Lukovic et al., (2012), in their paper "Reliable Concrete Repair – A Critical Review", highlighted that the composite system by the integration of the repair material with the existing concrete, forming a monolithic bond, would allow uniform transfer of stresses in the system.

The quality of the surface preparation of the substrate is a strong determinant of the success or failure of a project regardless of the repair material cost and quality of application technique employed. It is pointless to exert efforts to achieve good adhesion to a weak friable substrate as failure of the concrete surface is eminent in such cases. Similarly, a sound surface might result in poor adhesion if the surface is not properly prepared. The good bonding of repair material to the existing substrate predominantly relies firstly upon, the mechanical bond of a well prepared substrate and secondly, upon the chemical bond amid the repair materials. Several other factors determining the bond strength of the repair system, include exposure conditions, properties of the repair materials and concrete substrate to name a few.

Sawn Edges – Doing It Right the First Time:

Saw cutting is used to delineate the perimeter of the repair zone. A disc type mechanical grinder is used for saw cutting the edges along the perimeter of the repair area. The right angled saw cut to a depth of 10-15mm is recommended to avoid any feather edging and it should not be deeper than the reinforced concrete cover. Saw cut squared edges help contain the repair material. The saw cut edges should be roughened slightly by needle gun or hacking as polished vertical sawed face may result in poor bonding.

The geometry of the repair area should be in simple square or rectangular shapes. Sharp acute angles and re-entrant corners should be avoided. Some concrete repair field installers usually form excessive or tortuous edge conditions as they try to closely follow the geometry of the distressed concrete. Such complex and zigzag edge conditions often result in shrinkage stresses leading to cracking. Where saw cutting is not possible due to smaller areas, chipping tools should be used to remove concrete ensuring that the edges of the repair area are cut perpendicular to the substrate.

Removal of Spalled Concrete:

Most of the repairs require surface preparation comprising of roughening, exposure of the aggregates or removal of the damaged, delaminated and loose concrete. Regardless of the type of deterioration, all weak, flaky, unsound and disintegrated concrete must be removed. Defective concrete should be broken back to a sound and dense concrete surface. Prior to the removal of any spalled concrete from a load bearing structure, certified shoring must be provided to the structure. The removal of concrete usually starts with saw cutting the repair boundaries. The deteriorated unsound concrete in the centre of the repair area is then removed. Breaking out and the removal of concrete progresses from the centre to the outwards towards the edges. The next step is to remove the concrete near the edges without damaging the sound concrete at the interface.

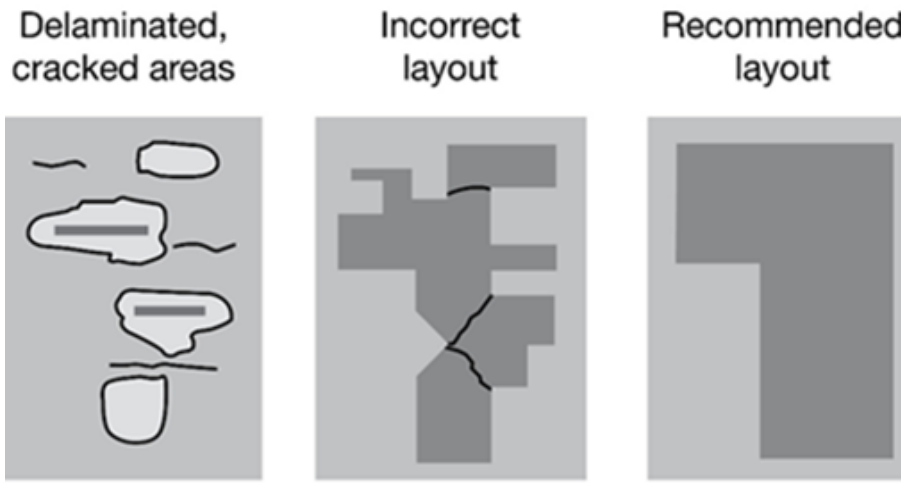
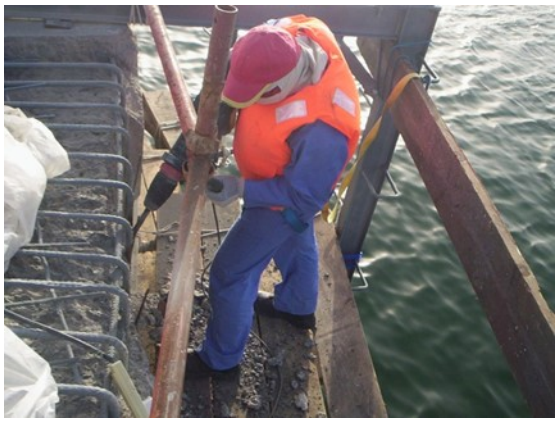


Figure 1: Concrete Repair Geometry. Source: ACI Webinar, 2013

The extent of concrete removal depends on the extent of damage. Concrete may be removed by impacting methods using power tools or by hydro-demolition such as water blasting and water jetting. The most commonly used concrete removal techniques are impacting methods such as hand held percussive equipment, pneumatic breakers, chipping hammers and scabblers where repeated striking of a concrete surface with a high power tool to break the concrete is employed. Whenever unsound concrete is removed using impacting methods such as percussive power tools, the surface of the concrete might exhibit micro-cracking or bruising that will form a weak plane acting as 'bond breakers'. It is recommended that the remaining concrete should therefore receive additional cleaning and preparation using wet sandblasting or water jetting. To avoid any micro-cracking of the concrete substrate, hydro-demolition or abrasive sand, shot or water blasting sometimes become the preferred choice for contractors.



Figures 2 & 3: Impacting Method - Removal of deteriorated concrete by jack hammer.

Concrete Surface Cleaning – Avoid Bond Breakers:

After removal of the deteriorated concrete the exposed concrete substrate must be cleaned with a high pressure water washing, oil free air compressor or other appropriate methods. Normal high water washing pressure of 15 MPa or lower water jetting/water blasting pressure of 35 MPa or less can usually be adopted to clean concrete surfaces that have already been prepared by impacting concrete removal methods. Though, some might consider it a redundant step, surface cleaning is crucial to attain the robust bond between the repair material and the substrate. Surface cleanliness is a critical step in surface preparation after the concrete removal process and prior to the commencement of repair materials application, as any dirt, debris or loose particles can act as 'bond breakers'. Surface cleaning facilitates repair materials to have direct contact with the host concrete substrate, increasing the surface contact area and roughness of the surface, resulting in enhanced anchorage of the applied repair material.

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Figure 4: Concrete substrate is ready to receive repair materials after final surface cleaning.

Steel Reinforcement Surface Preparation – Reaching Behind and Between Corroded Rebars:

On steel substrates there is a problem of corrosion. This normally takes the form of rust. Initiation of corrosion and de-passivation of reinforcement is only possible in the presence of water, oxygen and corrosive agents such as chlorides and carbon dioxide. The rust layer is mechanically weak, poorly bonded to the surface and must be removed prior to any application. According to the American Concrete Institute (ACI 546), all weak, spalled, severely cracked, damaged, and easily removable concrete should be chipped away from corroded reinforcement steel. All corroded steel in the repair area should be fully exposed to full circumference and thoroughly cleaned of all loose scale, corrosion deposits and other contaminants. An old rule of thumb is that at least 20-25mm of clearance around and behind rebar is required to ensure proper cleaning, encasement and bond of repair materials that also complies to the requirements of ACI, AS, EN and other standards.

If the deterioration of concrete has been caused by corrosion of reinforcement, the products of corrosion must be removed prior to the application of the repair material, or else the repair will be fugacious. If the structural capacity of the reinforcement is compromised due to chloride contamination, it is essential to remove all rust from the steel before proceeding. Steel reinforcement should be cleaned to achieve a surface preparation equivalent to AS1627 Part 4 Class 2.5. The preferred method is abrasive blasting (SSPC-SP 10/NACE No. 2) or water jetting (Vaughn O'Dea, 2011).

Figure 5: Steel cleaning and splicing by lapping after removal of concrete.

Exposed reinforcement in smaller repair sections can be cleaned manually by using hand or mechanical wire brush and emery paper to reach and clean behind and between the rebars. Exposure of steel reinforcement must also continue along its length until non-corroded steel is reached and continued at least 50mm beyond to show sound rust-free steel. If the steel has lost more than 25 percent of its cross-sectional area due to rusting, splicing of reinforcement bars should be carried out by butt welding the bars with backing plates, lapping the effected bars with supplemental reinforcement or by introducing coupler mechanical joints. The reinforcement bars used in repairs shall conform to the requirements of AS4671. An unbroken coat of anti-corrosion zinc rich epoxy primer is normally recommended to protect the steel reinforcement within repair mortars.

Bonding Agents – Bond Aiders or Bond Breakers:

There are number of repair failures recorded when concrete surface preparation prior to repair is neglected due to a false assumption that poor surface preparation can be compensated by using a bonding agent (Bissonnette et al., 2012). Engineers specify bonding agents as a ‘belt and braces’ measure to enhance the bond at the repair interface, but it should not be considered by any means a replacement of the surface preparation. Bonding agents provide an additional step and a layer that can create a weak plane if proper instructions are not followed. If the bonding agent is allowed to cure prior to the application of the repair mortar, it would rather act as a ‘bond breaker’ than a ‘bond aider’, causing failure of the repair.

Figure 6: Sprayed repair mortars, in particular, do not require bonding agents as the shotcrete process exhibit excellent bonding characteristics by itself.

Drunken Concrete – A Safe Compromise:

When repairs are to be carried out using cementitious mortars, the surfaces must be pre-wetted to achieve a saturated surface dry (SSD) condition after cleaning in order to avoid host concrete absorbing the moisture from the repair mortar that is in fact required for its hydration. Although, the term saturated surface dry (SSD) is somewhat subjective, yet many experts consider it a ‘safe compromise’ for pre-soaking the concrete. If the concrete is dry and ‘thirsty’, pre-soaking is of utmost importance. The concrete should be thoroughly pre-soaked so that the concrete is ‘drunk’. If the substrate is not pre-soaked thoroughly, the rate of movement of water from the repair mortar to the host concrete will be high due to the moisture imbalance between the adherent ‘substrate’ and the adhesive ‘repair mortar’. In SSD condition the substrate is damp and saturated but does not contain any free water on the surface. Free water at the surface must be avoided as it can impair the bond at the interface due to shrinkage leading to lower material strength and reduced bond strength.

Surface Preparation Safety – Be in Control of Potential Hazards:

The effect of the concrete removal on the structural integrity prior to the commencement of removal of existing deteriorated concrete, must be thoroughly assessed. In case of removal of spalled concrete or damaged reinforcement of structural elements, precautionary measures must be employed by providing temporary support. During the concrete breakout and removal process, dust and debris should be contained as not to pose any hazard to the stakeholders. The areas of repair should be examined to ensure there are no electric conduits, sockets or utility connection lines embedded that might get damaged during concrete removal. All effective measures should be adopted to ensure the safety of the structure is not compromised by repair activities.

Surface Preparation Testing

The tensile pull-off adhesion test of the existing concrete should be conducted as part of the condition evaluation report. To ensure that the surface preparation procedures were followed as per the specifications, the pull-off strength of the prepared surface prior to repair application is carried out. ICRI Guideline No. 210.3-2004, "Guide to Using In-Situ Tensile Pull-off Tests to Evaluate Bond of Concrete Surface Materials" is followed by most Engineers. In case of a significant deviation of the pull-off strength of the prepared surface from the tensile strength of the existing concrete, the result should be examined by the Engineer for additional surface preparation. Such benchmark criteria would allow the Engineer to establish and specify the realistic adhesion strength requirements for the on-site repair condition.

To prequalify the quality of a repair it is vital to evaluate the quality of surface preparation and eventually the durability of bond. This is done by conducting the direct pull off test on a representative sample area for the cured in-situ repair material. This step of surface preparation testing would verify the tensile bond strength of the repair material and the existing host concrete. During the course of the project, surface preparation need to be periodically validated using tensile pull-off test method, benchmarking Engineer's specifications and the values obtained during prequalification of the reference sample. Vicroads, standard specifications, section 689 suggest that the mean adhesion or pull off strength to concrete substrate at 7 days should not be less than 0.75 MPa, with no individual result less than 0.65 MPa for substrate mode of tensile failure within existing concrete substrate. Bond values for shotcrete and form-and-pour repairs typically exceed 0.75MPa and, in most cases exceed 1.0 MPa. ACI 503R and VicRoads Test Method RC 252.02 are commonly used standards for pull-off testing.

Conclusion:

The best of repair materials despite the best of mixing and application practices are destined to fail unless the concrete substrate is properly prepared. The intent of this article is to promote precise specifications for surface preparation rather than taking a broad generic approach. The conventional approach of surface preparation for concrete repairs such as 'clean and sound' should be avoided. This commonly used phrase is too ambivalent to specify the correct level of surface preparation. There is a need to go beyond the boundaries of 'clean and sound' approach. Field technicians and installers are the cornerstone in any concrete repair project. They must be provided with thorough technical training to enhance their skills. Surface preparation will often be pivotal in determining the overall performance and durability of a repair. A successful repair means that the resulting multi-layer system acts monolithic, ensuring long service life. Proper attention to surface preparation is essential to achieve a robust bond between repair materials and the existing concrete substrate. Only a strong bond would lead to a strong and durable repair. If you want to get the most out of the repair materials, then be prepared to prepare!

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About the Author

Hamid Khan working presently as Product Segment Manager – Repairs and Grouts at Parchem (DuluxGroup), Australasia, holds a bachelor degree in Civil Engineering discipline. He also holds a double Master in Business and Strategy from the University of Wollongong. Hamid is certified in Concrete Technology and Construction, by City & Guilds of London Institute (UK) and is a qualified expert in concrete repair & refurbishment with 19 years of experience in the industry. Hamid is a regular speaker at various industry related National and International Conferences and Seminars. Hamid contributed to articles for Australasian Concrete Repair Association (ACRA)- Concrete Connection, Concrete Institute of Australia (CIA) – Concrete in Australia, Australasian Corrosion Association (ACA) – Corrosion and materials, The Australian Institute of Building (AIB) – Construct for Chartered Building Professionals and other leading construction magazines.

Hamid is also an active board member of Australasian Concrete Repair Association (ACRA). He was associated with Fosroc International in Dubai for 14 years taking up various roles in technical and management. Hamid's experience comes from the Gulf, Middle East, Europe, East Asia and Central Asia.

Excellence in Project Delivery and Concrete Repair

ACRA SEMINAR IN HAWTHORN, VIC - 5 APRIL 2017

On April 5 at Swinburne University Hawthorn Campus, ACRA will hold and interesting seminar on Excellence in Project Delivery and Concrete Repair.

Your speakers & topics are:
Nathan Power—SRG Limited- Award Winning Project Widening of Princes Highway East Bridge over Barwon River at Winchelsa (*Pictured*)
Andy Caddy—Absafe - Award Winning Project Hazelwood Unit 5 Chimney Stack Repair
Hamid Khan—Parchem - Concrete Repairs in Accordance with EN1504: A guide to good practice
Click here for details & to register.
Click here for map of location/venue

Sponsored by:

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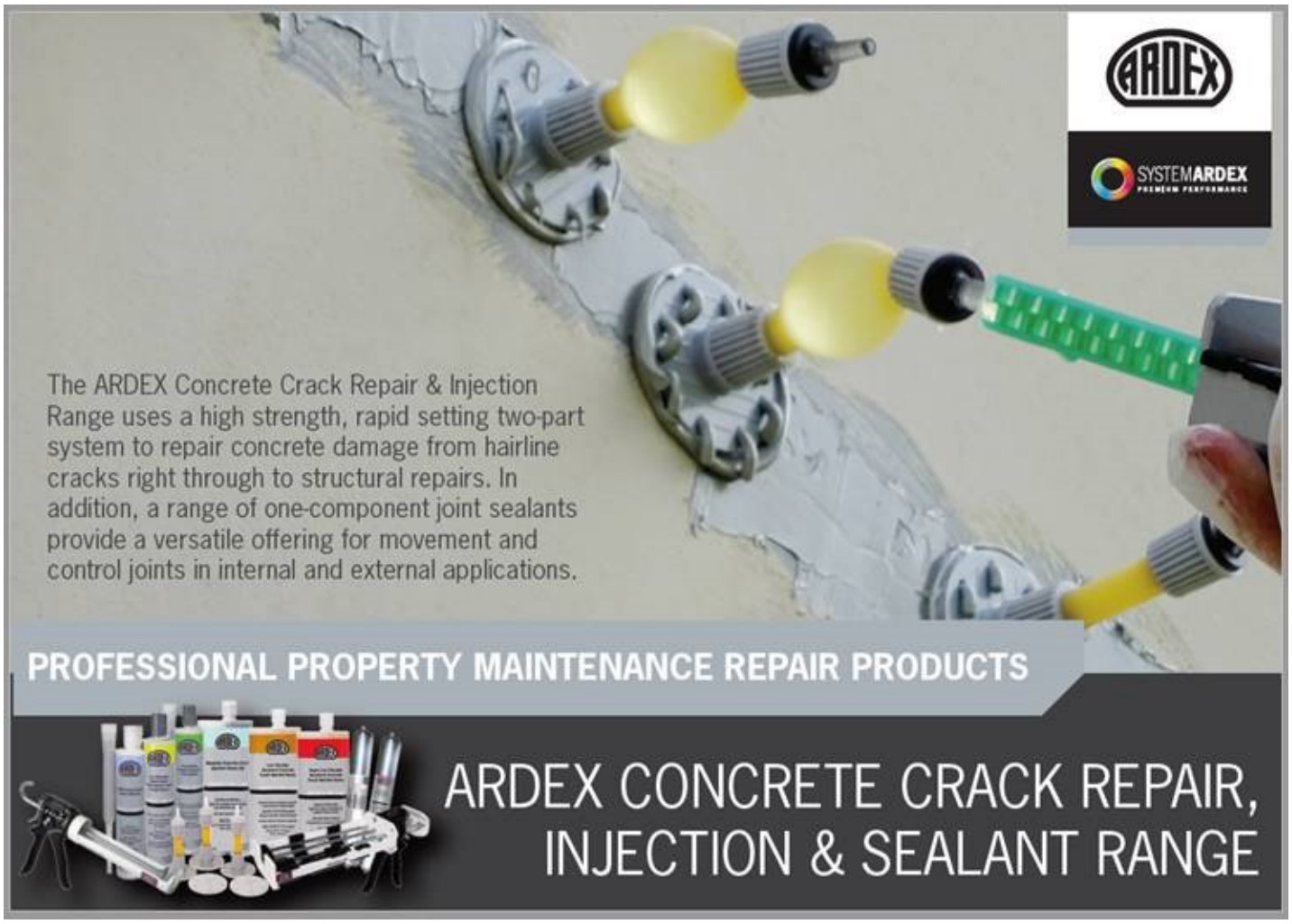
ACRA at ARDEX

ACRA was recently invited by ARDEX Australia to take part in their 3-day event, and it was great to see everyone's excitement about their new and improved range as well as the tour of their facilities.

On one of the days it was focused on concrete repair products and Peter Johnsson, Past President of ACRA and one of our major speakers of our full day course on Concrete Repair and Protection, was invited to hold a tailored in-house course on Concrete Repair and Protection.

ACRA always enjoys taking part in our Members launch/ relaunch days as well as putting together in-house tailored courses.

For more information on our course and how we can tailor this for you, email info@acrassoc.com.au or phone 02 9645 3692.



Residential Concrete Walls

Five Dock, Sydney, NSW

MCM Marine & Civil Maintenance
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Late 2016, MCM was awarded a Contract by City of Canada Bay Council to rehabilitate a section of deteriorated seawall. Located at the southern extent of Kings Bay along the Parramatta River in Five Dock, the existing seawall is 25m long and 2m high and extends along council owned land.

The scope of work consisted primarily of constructing a new sprayed, reinforced concrete wall, installation of drain pipes to alleviate any water pressure build up behind the wall, and placement of a rock revetment to protect the wall from storms and give it added stability. For added durability, the new reinforcing steel was all galvanised. Although the scope of work was standard practice and relatively straightforward, there were several challenges to be found in the project's situation.

Located in a residential area, a foreshore walk extends along Kings Bay and provides pedestrians with extensive shoreline access. At the seawall, however, the only access is along the beach at low tide.

The project team, led by David Massey, developed and implemented

various control measures to ensure the safety of the public, including local landholder notification, site barriers and signage, and provision of alternate safe access for pedestrians.

The waterway interface, Kings Bay, is zoned W2 Environmental Protection under the Sydney Regional Environmental Plan (Sydney Harbour Catchment 2005) and required environmental controls to be implemented to protect the site of the works.

Key controls included protecting and managing work areas from the effects of high water levels and wave action, implementing construction methodologies that stopped any potential construction waste from entering the waterway and the installation of a construction silt boom to control the movement of silt.

After the reinforcing mesh was fixed to stainless pins dowelled into the substrate wall, it was sprayed with ready-mixed concrete in one day. The rock revetment was placed the following week, and completion on time and on budget was reached just before Christmas.

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Give me a C! Give me an O! Give me another C! Give me an A!…

Andersal completed concrete repairs behind the famous Kings Cross Coca Cola sign last year before it got its new face lift for Claude Neon.

It may not be quite how it actually went down, but it was something like that when four people bid more than $100,000 for the individual neon letters of the famed Kings Cross Coca-Cola sign last year.

More than $100,000 was raised for the Wayside Chapel when the letters from the old iconic billboard were sold off.

The eight letters, which had presided over William Street since 1974, were auctioned off to raise money for the nearby Wayside Chapel.

Photo: One of the three letter "C"s, all of which were purchased by an anonymous art collector.

For 21-year-old Max Shand, the dream of owning a three-metre by 2.5-metre letter "a" was borne out of a passion for Sydney and memorabilia.

"I see the Coke sign as completely entrenched in Sydney's city. I've always absolutely loved the sign and what it stands for in the cityscape," Mr Shand said.

"...It's always been a focal point, a place where you meet your friends."

Mr Shand parted with a cool $12,700 to snag the letter "a", which he plans to hang from the Surry Hills office balcony where he works.

He also successfully bid on behalf of his parents for a letter "o", which is destined to be hung as an art piece in their home.

Andersal were also lucky enough to view art work by an unknown artist behind the old Coca Cola sign.

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Technical Specifications—Where the Trouble Starts

By AustraLaw

It is no secret that the source of most problems in a technology-centric contract is the specification.

(1) If the specification is vague, or mistakenly relies on the propensity of the reader to fill the gaps with the same assumptions as the writer, then each party will have a different understanding of what is to be delivered. This leads to two potential problems:

(a) The supplier delivers something different to what the purchaser actually requires; or
(b) The purchaser can continually use the ambiguity in the specification to deny payment or insist on endless rework.

Ultimately, each party will rely on its own interpretation and assert that the other party has breached the contract.

(2) If the specification turns out to be unworkable, there will need to be appropriate contractual mechanisms and an effective working relationship to resolve this. Without this:

(3)

(a) The purchaser will assert that the supplier is trying to deliver less than what was agreed to, or repudiating the contract; and
(b) The supplier will be burdened with the cost of rework or even abandoning the project.

The end result (if delivered) will likely struggle to fulfil the purchaser's purposes for the project. Again, this difference in what each side had in mind when entering the contract provides fuel for disputes.

It is little wonder that most disputes come back to the specification, as it provides the baseline on which the major parts of a technology-centric contract rely:

(a) Payment terms rely on acceptance that certain features of the specification have been met;
(b) Warranty terms rely on answering whether the deliverables have failed to perform according to the specification;
(c) Maintenance and service level agreements rely maintaining or returning the deliverables to the requirements of the specification;
(d) Liquidated damages clauses will rely on determined whether certain aspects of the specification have been met by a certain date;
(e) Variation clauses rely on determining the extent to which a change request is a deviation from the agreed scope of work;
(f) Common law rights of termination and damages rely on discerning the disparity between what was delivered and what was required;
(g) The pricing of the contract relies on the interpretation of what is required to satisfy the specifications;

And ultimately, a failure to translate purchaser expectations into a specification, which, if delivered will satisfy them, risks the agreement ending in disputes and project failure.

The trouble with specifications is that they exist at the intersection of three project vulnerabilities:

(1) Specifications are often drafted by engineers, or other technical professionals. These professionals are accustomed to communicating using the jargon and terminology of their respective fields and not for the broader audience that a contract specification must communicate to. They risk drafting the specification in a manner that is riddled with numerous assumptions because in their mind those assumptions 'go without saying'.
Unfortunately, any audience outside that area will apply their own assumptions to fill those gaps and arrive at a different interpretation of what is required. Furthermore, a non-technical audience (e.g. lawyers, managers and business people etc) will often be unable to traverse those assumption-gaps in the specification and struggle to read the document at all.
(2) The lawyers engaged by the parties to draft and negotiate the contract often lack the technical literacy to address shortcomings in the specification, don't know the right questions to ask, and won't want to concede that they don't understand it. As a result they are likely to gloss over the specification and revert to risk-shifting clauses to pin the cost of eventual project issues on the other party. For those who desire to 'leave the contract in the draw' while administering the project, risk-shifting clauses provide little assistance.
(3) The more unique a project is the more difficult it is to predict all the issues that may arise. As the saying goes, 'no plan survives first contact with the enemy'. The art in drafting specifications, is in providing adequate quality and performance goals, while allowing room to adapt to handle uncertainties as they occur during the life of the project.

For example, there may be known uncertainty at the outset about what exactly will be required, or whether certain performance levels can be guaranteed. Options to deal with this may include the use of a high level specification, with a more detailed specification to later be accepted or rejected against that high level specification once those unknown have been addressed; or the specification might provide room for the supplier to determine the best trade-off within specified tolerances.

The best way to keep a project on track is to avoid disputes from arising at all. The most fertile origin for disputes in a technology-centric contract is the specification. In the worst case, it will be a legally trained mind (i.e. a judge) that will finally determine the 'proper' meaning of the contract.

Therefore, the best means to de-risk a technology-centric contract is to engage professionals at the start who have the skills and expertise to critically analyse specifications from both a legal and technical standpoint. Engaging such expertise before signing the contract reduces the risk to all parties and ultimately, makes the project much more likely to succeed.

Calendar of Events

Mark your diary!

Date	Month	Event Name	Link
20-22	March	QLD -Coast & Marine Structures	Click here for 10% discount
5	April	VIC - Excellence in Project Delivery & Concrete	Click here
5-6	June	NSW - 2 Day Corrosion & Protection of Concrete	Click here
11-12	September	QLD - 2 Day Corrosion & Protection of Concrete	Click here
22-25	October	SA - Advances in Concrete Materials and	Click here

Click the image for more information and to register.

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