Introduction

The Durability Series is a set of Concrete Institute of Australia recommended practices that provide deemed to satisfy requirements applicable to all concrete structure types based on standard input parameters for design life, reliability and exposure. The series includes details on project planning and implementation which if followed will increase the likelihood that the specification, design detailing and construction will be optimal to achieving the developer and community expectations regarding the long term performance of concrete structures. Also included are methods for modelling degradation over time and for crack control design. Thus the series provides what is described as a unified durability design process.

Prior to around 1970 concrete was generally regarded by asset owners, designers and contractors as a reliable construction material that provided long term durability with relatively little maintenance. Subsequently, premature deterioration of concrete structures, arising from changing cement characteristics, quality management and other factors, damaged this reputation. Because concrete is a complex material, research into the cause of problems and development of appropriate new rules and operational methods has taken a long time. The durability series provides recommendations that if followed will largely eradicate premature deterioration.

Whilst research into concrete durability continues, the knowledge on exposure significance, deterioration processes, materials properties and workmanship implications has developed significantly over the last 30 years. In addition new cementitious materials, admixtures and additives have been widely introduced. Much more advanced concretes are now available. New durability design practices have also been developed, including durability modelling methods, and new methods of construction have been introduced. However, to an extent at least, these developments are not fully reflected in a clear and unified manner through the Australian Standards dealing with concrete durability requirements (e.g. modelling methods, use of fly ash, slag and silica fume, use of galvanised and stainless steel reinforcement). The durability series provides recommendations on durability design using a wider range of concretes and reinforcements, and details how to implement new durability design methods.

Durability requirements in Australian Standards are fragmented through different standards and their commentaries dealing with concrete durability requirements for different structure types (e.g. AS 2159, AS 3735, AS 4997 and AS 5100.5). Perceived conflicts between these documents (e.g. higher covers in AS 3735 than AS 3600 for the same life and exposure) might sometimes be explained by the different owner requirements (e.g. reliability required) but reasons for the differences are not given and the associated assessment methods not clearly stated. To some extent the concrete industries energy for contributing to development of durability codes is diluted through maintenance of the multitude of codes that cover the same topic in variable ways.

For many concrete elements in mild exposures incorporating the recent durability related developments into a unified durability design process for all structure types may make little difference to their durability design because existing code deemed to satisfy provisions often provide adequate performance. However, for elements in more severe

<table>
<thead>
<tr>
<th>National Seminar</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIA Concrete Durability Series</td>
</tr>
<tr>
<td>10-17th November</td>
</tr>
</tbody>
</table>

Most of the Z7 durability documents will be presented in detail by five of the Task Group chairmen. This is a one off opportunity to gain an insight into the background to the documents.

Contact: (02) 9955-1744 or technical@concreteinstitute.com.au
exposures, guidelines that comprehensively detail how to assess owner’s needs, environmental exposures and materials requirements; how to specify performance or prescriptive materials properties; and how to ensure construction is appropriate to the design will provide structures that meet their durability requirements more consistently. The durability series provides the required guidelines.

The Concrete Institute of Australia first introduced Z7 “Durable Concrete Structures” in 1990 as an initial response to concerns about the poor durability performance of some concrete structures. This was revised in a second edition in 2001. This gave some excellent information on how to achieve durability but did not set out to provide a set of unified design guidelines as an alternative to the approach in the Australian Standards noted above.

The Concrete Institute of Australia’s Durability Committee was formed in late 2008 to review Z7. In view of the committee’s perceived need for a broader review of durability requirements it managed workshops around Australia in mid-2009 to review issues with concrete durability practices and standards in Australia. The outcome from these workshops, and other feedback from Concrete Institute of Australia members at the Concrete Institute of Australia National Conference in 2009, was that comprehensive and unified durability guidance was required. In response, the Durability Committee established Task Groups to produce a series of recommended practices as a major revision to Z7 that would form a durability series. The series comprises:

- Z7/01 Durability - Planning
- Z7/02 Durability - Exposure Classes
- Z7/03 Durability - Deemed to Comply Requirements
- Z7/04 Durability – Good Practice Through Design, Concrete Supply and Construction
- Z7/05 Durability - Modelling
- Z7/06 Durability - Cracks and Crack Control
- Z7/07 Durability - Testing

The durability that the owner and community require from structures will only be obtained if specific consideration is given to how durability requirements impacts on construction cost, inspections needs, maintenance requirements, aesthetics and operational and community costs that unplanned maintenance brings. While strong emphasis is placed on achieving the design life, durability must be met long into the future, possibly well past the initial design life. The durability series will go a long way to providing the necessary tools for design and construction of durable structures based on the latest understanding of exposure, materials and deterioration process.

**Z7/01 Durability Planning**

Z7/01 preparation was chaired by Rodney Paull with an active task group comprising major asset owners, consultants, contractors and asset managers. As such it can claim a broad industry agreement on the ideal approach to durability planning. Whist there has been various papers published on durability planning this is the first industry guideline on the topic.

Information on processes involved in concrete deterioration are available for engineering analysis but a formal process for achieving durable structures in design, construction and operational maintenance is missing. Durability planning outlined in Z7/01 provides a system to formalise the process of achieving durability through appropriate design, construction and maintenance.

In engineering terms, durability planning is cost-effective selection and usage of materials combined with design processes, construction methods and detailing to achieve the asset owner intended service life without premature unexpected operational maintenance. Asset deterioration also impacts on the
community and this must be accounted for in the design process. A technical analysis determines the
nature and rate of materials deterioration for given macro and micro environmental conditions, which is
used to influence the design, construction and operational maintenance during the service life.

Z7/01 sets out the process of planning to achieve the required level of durability. The durability
planning outcomes will be delivered in a Durability Assessment Report specific for the project. This
will describe how the desired level of durability will be achieved and ensured using appropriate tools
and recommendations given in Codes and Recommended Practices (e.g. CIA Z7/02-07).

A Durability Assessment Report provides a continuous link in durability objectives between design,
construction and maintenance. Durability planning evaluates, explains and provides solutions for all
stakeholders. Greater confidence is provided for the design and required service lives to be achieved.

Durability is provided with improved confidence when the concrete structure asset owner is actively
involved starting from the project brief stating specific durability requirements. Designer and/or
contractor provided durability without adequate asset owner defined formal requirements has
uncertainty that an optimum whole of life cost will be achieved. In a worst case scenario of reduced
structural adequacy and/or functionality, asset owner maintenance cost funding and resources may be
excessive to keep the asset operational or the asset owner may face rapid premature depreciation.

Concrete structures recommended to use durability planning will have durability design requirements
that are complex, critical or uncertain. Durability planning is not expected for simple structures in
exposure conditions excluding moderate or severe (e.g. house slab and paths).

The Durability Assessment Report issued will explain the durability requirements and provide details
to be included in the project design reports, specifications, design drawings, asset maintenance plans
and/or operation and maintenance manuals. This report may be a page for simple structures or detailed
for complex, critical or uncertain structures. Durability checklists in tabular form provide useful project
guidelines complementary to the Durability Assessment Report.

Z7/01 provides information on durability planning during design, construction and operational service
life phases for all concrete construction stakeholders.

The document is intended to inform and inspire designers about the benefits of durability design so
they can inspire asset owners to elevate durability planning to a position alongside structural and
architectural design.

**Z7/02 Durability - Exposure Classes**

Frank Papworth chaired the Z7/02 committee which comprised various durability technical experts and
all agreed current Australian Standard durability classes have three issues in how they deal with
exposure classifications:

a) Exposure classes for different structure types, e.g. piling, marine structure, water retaining
structures and general concrete structures, can have different exposures classifications. In reality
the exposures are common to all concrete and use of different class types for the same exposure
is confusing.

b) The same exposure class is used for different exposure types, e.g. a B2 exposure could be due to
chloride exposure or sulphate exposure. This makes it difficult to provide a range of solution
that will always be applicable to each exposure class.

c) The exposure classes are not in line with those used in ISO or European standards. This makes
it difficult to compare Australian durability requirements with international requirements.
Hence Z7/02 provides different exposure classes for each type of exposure and applies them to concrete in all structure types. The ISO 16204 exposure classes are adopted where possible but the ISO format for exposure classes is adopted in all cases.

Different projects will have different design life and reliability requirements and this also needs to be factored into the durability design. In some cases the different Australian Standards may have incorporated these aspects into the exposure classifications and this may account for why the exposures classes are different in different Australian Standards. However it is possible to allow for different life and reliability requirements for individual elements rather than forcing every project of a certain type to adopt the same life and reliability level. For example some elements of a marine structure may be highly critical and require a high reliability associated with an ultimate limit state (e.g. reliability around 4) while others may have virtually no failure consequence should they deteriorate and have a much lower reliability requirements (e.g. as low as 0.5). The same structure may only be required for 20 years or 100 years. Further details on design life and reliability can be found in CIA’s Z7/01 – Durability Planning.

The base for the European classification was the fib Model Code 2010 and EN201 as these have had extensive recent discussion from participants from all over the world. Where a departure from these documents is used in Z7/02 the reason for the departure is given. The principle reason for departures is that in Australia a broader range of exposures in some exposure types has been recognised.

The exposure classes discussed in Z7/02 are the criteria against which deemed to comply provisions in Z7/03 are defined. Hence Z7/02 can be considered a commentary on the exposures used in Z7/03.

Whilst exposure and the access of moisture has an influence on deterioration associated with items such as Alkali Silica Reaction, Delayed Ettringite Formation, Shrinkage and other materials related aspects the control is more related to materials design and hence specific exposure classes have not been developed for them.

Exposure classes include:

- XC - atmospheric carbonation inducing,
- XS – seawater exposure,
- XD - chlorides other than seawater,
- XA - aggressive chemicals in ground exposure
- XF - freeze thaw,
- XG - exposure to liquids, vapours and gases,
- XM – water migration
- XX - metals in the cover zone
- XR - abrasion
- XI - moisture and ASR
- XH - temperature and delayed ettringite formation

A common criticism of the first version was that there was no guide to how the exposure classes in Z7/02 related to exposure classes in Australian Standards. Appendices have now been added that describe this.
**Z7/03 Durability - Deemed to Comply Requirements**

At the commencement of the task groups it was agreed that deemed to comply requirements would be prepared after the other Z7 recommended practices so that it could be based on them. Hence at the time of going to press attention is only just refocussing on Z7/03. The group, chaired by Frank Papworth, set the following as the approach to be followed:

- Provide requirements for each exposure class (e.g. chloride, sulphate, acid, atmospheric gases)
- Requirements linked to cement systems including GP cement, fly ash, slag and silica fume
- Provide guidance for galvanised and stainless steel reinforcement, prestressing and steel fibres
- Give recommendations for effect of coatings on other durability requirements
- Define significance of curing methods on other durability requirements
- Provide advice based on minimum cover.
- Incorporate reliability as a factor in determining durability requirements
- Design lives of 25, 50, 100 and 200yrs to be considered.

Reliability design is a major new introduction to durability design. As shown in Figure 1 reliability vs time for marine and coastal structures has a steep reduction initially and then begins to flatten out. For most concrete the reduction between 50 years and 100 years is not high and from 100 years to 200 years is even less. This is because the rate of chloride ingress is proportional to the square of the cover. It is proposed that factors will be applied to cover to allow for both design life and reliability for corrosion.

**Figure 1 : Reliability based on full probability analysis for a coastal structure using a 0.45w/c ratio and 45mm minimum cover**

Developments should be significantly advanced by the time of the Durability Seminars in November but the final document is unlikely to be complete until mid 2015 as requirements will need to be cross checked against experience and research.

**Z7/04 Durability – Good Practice Through Design, Concrete Supply and Construction**

Australian concrete construction standards more generally focus on minimum design and material requirements and with the exception of a few more detailed “Hand Books” standards are unlikely to provide more informative recommendations about how to design or construct a structure to get the target life expectancy. The previous edition of Z7 gave a good backbone for Z7/04 but Tony Thomas
and Frank Papworth, the principle authors, found Z7/04 kept growing as different aspects of design, concrete supply and construction were considered.

As the title suggests, Z7/04 has applicability to more general concrete design and construction as well as concrete requiring specifically higher levels of durability. Z7/04 provides more specific detail covering areas such as the impact of specifications and the contract process, impacts of design on construction, more detailed view of the materials used in construction, material quality control processes, construction process and supervision as well as some detailing issues in common structural elements that may present potential durability issues to the designer & constructor. In addition to this an appendix section is included on reinforcement spacers and chairs as this is an area that has demonstrated to cause weakness in durable construction and is rarely adequately specified.

The designer and durability planner must understand not only the intended design but must understand the material properties and consider how these properties can be delivered during the construction process. There are many elements to this delivery process that impact on the final structures durability and Z7/04 provides information that helps to highlight the more critical areas of concern from design detailing through material supply to construction of the structure for all concrete construction stakeholders.

The document is intended to inform all parties involved in design and construction about the benefits of durability planning and subsequent control of implementation so they can deliver the expected level of maintenance and life of the structure to the asset owners. Different sections deal with:

- **Detailing** - Poor detailing of the structure can lead to various issues and common issues are outlined. Typical details that will help overcome durability problems are provided.

- **Pre pour planning** - The concrete supplier cannot know if concrete supply is fit for purpose with no awareness of where and how the concrete is to be placed. As the concrete supplier is often best placed to advise on what can be provided to overcome a particular problem part of the pre-pour planning is to introduce the supplier to the proposed pours. Many experienced concrete engineers will review the contractor’s method statement and will be able to pass useful comment. Hence another part of pour planning is proper documentation of the methods to be used and dissemination of approved method statements to those that will place the concrete.

- **Quality management** - Lack of Quality Management throughout the production, delivery and placing process may lead to construction of a cheap but poorly performing structure.

- **Concrete materials and concrete supply** - Although AS 1379 provides useful advice there are a number of aspects left open to the designer and these are discussed here. Additional recommendations on issues not covered by AS 1379 are also provided.

- **Reinforcement Types** - Reinforcements of various types are used in construction and these all impact on the potential durability of the structure.

- **General construction issues** - This includes placing, finishing and curing of concrete plus training issues and solutions. Lack of training is one of the most common causes of construction defects and subsequent durability issues. Even the simplest of training can save the contractor and owner huge re-work and repair costs respectively. Hence some provision in the contract should be made for the contractor team to be adequately trained.

- **Construction of different element types** – Different sections consider durability aspects of various ways in which concrete elements are constructed by insitu cast, precast and sprayed concrete.
Z7/05 Durability – Modelling

Durability modelling is a major area of development in Europe with fib Commission 8 having two active task groups dealing with different aspects of modelling which support the modelling sections of fib Model Code 2010 and ISO 16204. Shengjun Zhou is the principle author of Z7/05 but has been supported with input from Frank Papworth based on work of fib Commission 8 (previously Commission 5) where he is deputy chair.

Durability design of a reinforced concrete structure mostly involves selecting suitable concrete compositions and related durability measures for a specific exposure condition to achieve the specified design life. There are mainly four approaches to conduct durability design as defined in fib Bulletin 34 (2006). These include (1) deemed to satisfy design, i.e. complying the durability requirements in various codes, (2) avoidance of deterioration, e.g. use of stainless steel to avoid potential issues with black steel corrosion, (3) partial safety factor design with deterministic modelling, and (4) full probabilistic design based on stochastic modelling.

In the past, most concrete structures were designed using a ‘deemed-to-satisfy’ approach by following code requirements, which was predominantly established based on long term field observations. The durability outcomes using this approach were a mixture of some successes and some failures. It was found that the failures occurred more frequently on the structures in aggressive conditions built since 1970 while structure built before that performed generally better.

Although the causes of the change have not been fully understood, this change has coincided with many changes including the cement characteristics (containing more C₃S and being finer), climate change (higher temperature and more C₂O in atmosphere) and construction practices (poor curing and compaction). These changes have not be reflected in the durability requirement by various Australia Standards.

Due to lack of long term durability data on the new materials characteristics and change of exposure conditions, a 'deemed-to-satisfy' approach may not be sufficiently reliable in some case and overly conservative in others where higher performing materials are used. The avoidance of deterioration approach can reliably provide a superior durability performance. However the associated high cost discourages wide application except on some critical elements in critical projects.

However, as an alternative durability design method, durability modelling (of either full probability design or partial factor) based on current material characteristics and mathematics has a potential ability to provide a much more reliable durability outcome if appropriate models and parameters are adopted. It is especially effective to predict long term performance of concrete structure in chloride laden condition and carbonation condition.

The advantage of modelling approach is that it does not rely on the observed long term information on the performance of field concrete structures and it can be adopted more aggressive condition compared those in the codes. Such a modelling approach has been increasingly applied in durability design for major infrastructure projects in Australia and around world. In addition, modelling approach is the most effective and essential tool to determine the remaining service life of existing concrete structures in condition assessment process.

Various models and preferred input parameters have been established and used in the past. However they produced significantly different prediction results and consequently different durability requirements even for the similar conditions and materials. Apparently, some used models and associated input values must be incorrect, incomplete, and/or inappropriate for the prevailing conditions. Therefore, to achieve accurate and reliable modelling outcome without a risk of premature durability failure or being too conservative at a high cost, it is critical to select suitable durability
models and input parameters across the industry. Only by this approach can consistent durability designs can achieved with a reliable durability outcome.

The objectives of Z7/05 is to review commonly used models and their input parameters for chloride diffusion, carbonation and corrosion propagation process so as to be able to recommend the most suitable models and input parameters with their statistical distributions. However, considering the complex nature of concrete deterioration process and insufficient researches on this relevant subject, this current guide is considered to be a working document which will be updated with more understandings and new findings in future.

**Z7/06 - Cracking and Crack Control in Concrete Structures**

Professor Ian Gilbert is chair of TG5. He has undertaken a review of the current literature on crack control, including CIRIA C660, and is very familiar with current code requirements. He has also been managing a significant research programme on this topic and important results will be available to feed into TG5’s recommended practice note by the end of 2014. This is a major topic and justifies a CIA national seminar in its own right. This is planned for November 2015 to coincide with the release of the Z7/06.

Z7/06 is a comprehensive treatment of cracking and crack control. It is a guide for practising engineers on how to avoid excessive cracking (in all its forms). It provides the best advice available for designing and constructing durable reinforced and prestressed concrete structures for crack control, including case studies and worked examples.

At present, there is no standard method for calculating crack widths. The methods outlined in CIRIA C660 are often used for early-age thermal crack control and a variety of methods have been proposed for estimating the width of load-induced cracks. Irrespective of their cause, crack widths are known to vary with time and are greatly affected by temperature changes and by drying shrinkage. Most current approaches do not include the design shrinkage strain $\varepsilon_{\text{cs}}$ as input into the crack width calculation, and consequently, they cannot hope to accurately, or even adequately, predict final crack widths.

The mechanics associated with cracking caused by early-age thermal deformations, restraint to drying shrinkage, and external loads are all different. Whatever the cause, each type of crack is controlled by reinforcement and the width of the crack depends on the stress in the reinforcement crossing the crack. *Cracking and crack control in concrete structures* presents a consistent and rational approach for predicting crack widths in concrete structures and guidance is provided on how this approach can be used for the determination of final crack widths in a variety of common design situations, including example calculations for early-age cracks, restrained shrinkage cracks and load-induced cracks. The document also provides guidance on the acceptable final calculated crack width (both average and maximum widths) from a durability point of view in all the various exposure classifications and how this varies with the design life of the structure. With the calculation procedure clearly specified, limits can be placed on the maximum calculated crack width, without attempting to ensure that every crack in the actual structure meets the contractual requirements.

In addition to providing advice on the causes and assessment of cracking in the hardened concrete, the document provides information and guidance during construction to avoid cracking in the wet concrete due to plastic settlement and plastic shrinkage.

*Cracking and crack control in concrete structures* will fill a current void. The existing approach for crack control in AS3600-2009 is often unreliable, quite inflexible, and unrelated to the specific durability requirements of the structure. For cracks caused by the applied loads and resulting from bending and direct tension, AS3600-2009 requires that the stress in the reinforcement crossing the
crack due to service loads does not exceed a specified maximum value. The maximum value depends only on the bar diameter or the bar spacing. In addition, certain detailing requirements are imposed involving maximum limits on concrete cover and bar spacing. These requirements are independent of the exposure classification, the type and importance of the structure, the mix proportions, the concrete material properties (including the shrinkage strain), the heat of hydration, etc. – all of which affect crack widths and, therefore, should be considered in the design for crack control. With regard to restrained shrinkage and temperature cracking, minimum quantities of reinforcements are specified depending on the whether a “strong”, “moderate” or “minor” degree of crack control is required. Again many of the factors that affect crack widths are not considered, including the level of shrinkage or the exposure classification.

Z7/07 Durability – Testing

Warren Green was the chairman of Z7/07 but authorship of the document was widespread, not surprisingly given the broad nature of the testing methods. Z7/07 provides guidance on performance tests for durability design and implementation. Often several test methods supply similar information. The limitations and advantages of test methods are reviewed, and recommendations provided on which test is the most suitable for project specifications.

Test methods are available to assess various aspects of durability performance through a concrete structure’s life cycle including:

- Mix Acceptance Tests (including tests to validate values used in modelling)
- Tests For Quality Assurance
- Tests Where Placed Concrete is Suspect
- Tests For Condition Monitoring

A wide range of tests designed to demonstrate the potential durability performance of concrete have been introduced over the years. This has caused some uncertainty for:

- Asset Owners: To understand what methods are available, the appropriateness of those methods to the structures’ exposure, environment and life cycle, and the most cost effective testing regimes to achieve the required outcomes and level of certainty that they are looking to achieve.
- Designers: To know which tests are the most appropriate to specify and how much test data is required to ensure that the level of statistical confidence from the test results underpinning the design is appropriate.
- Contractors and Material Suppliers: To understand and have confidence in the consistency, repeatability and validity of trial data and quality control performance testing they are required to undertake for compliance with the project specification.
- Suppliers of Laboratory Testing Services: To maintain and calibrate equipment, train staff, maintain third party accreditation for the tests (e.g. perform the tests to sufficient frequency, provide regular proficiency training of staff and keep detailed records) and competitively price test methods despite some being not often specified.

Z7/07 aims to reduce the confusion and uncertainty. It provides guidance on performance tests for durability design and implementation. Often several test methods supply similar information. The limitations and advantages of these methods are reviewed, and recommendations provided on which test is the most suitable for project specifications.
Design phase durability testing requirements are recommended to be clearly specified for four stages:

- Mix trials to confirm the mix is suitable.
- Quality assurance tests as construction proceeds.
- Tests at the end of the defects liability period to create a list of items for repair.
- Tests during the design and service life including monitoring.

Construction phase materials testing and selection requirements recommended are:

- Materials testing and selection must be completed in accordance with the project specifications prior to use in the works. Additional testing is required prior to a change in supply of materials or a new source of materials.
- Verification of concrete mix designs to meet project specification durability requirements can take considerable time, and unscheduled changes in concrete supply during construction may result in program delays. Durability testing of concrete such as chloride diffusion, water permeability, drying shrinkage, etc. may have a long test period (e.g. up to 3 months).
- Variability of durability tests must be taken into account by the durability consultant, with specification test criteria allowing for alternative solutions to achieve the required durability if the test results do not achieve the specified values. This can be achieved by conservative durability design and/or provision for use of additional measures such as protective coatings or special additives or other measures.

Operations and maintenance phase monitoring and testing recommended are:

- Practical Completion Inspection - Prior to a structure going into service it’s important to determine if any defects need to be contractor repaired and to document the initial structure characteristics and condition for future reference and comparison.
- Periodic In-Service Visual Inspection - A reactive approach to on-going maintenance be limited to visual inspections only and these may be performed on a regular basis or ad-hoc. This may be adequate provided no major defects are found and may be sufficient to prevent minor defects from becoming major ones. If appropriate, follow up repairs are performed as required. This approach may be suitable for minor structures and/or structures with a short design life.
- In-Service Condition Monitoring and Testing - Proactive maintenance will involve early intervention to prevent or delay the onset of corrosion initiation. This will require regular inspections in conjunction with additional activities such as structural monitoring and non-destructive testing, as required.

If significant repairs/strengthening have been carried out, then a post-intervention inspection should be carried out along similar lines to a new structure first inspection mentioned above.

This document is intended to inform all parties involved in design, construction and maintenance about the benefits of durability performance testing and how as part of a durability planning and implementation process will lead to an increased likelihood of achievement of design life of structures and buildings.

**Epilogue**

Frank Papworth, the chairman of the concrete durability committee prepared this article largely based on extracts from the various durability series documents. The article was reviewed by the other Task Group Chairmen, i.e. Rodney Paull, Warren Green, Tony Thomas, Shengjun Zhou, Ian Gilbert.
After 5 years chairing the Durability Committee Frank Papworth steps down in January 2015 and Rodney Paull, a major contributor to the committee since its inception, will take over the role and develop the groups agenda going forward.

The separate recommended practices were always seen as the first step in the process of developing the basis of a new Australian code for concrete durability and this was strongly supported by CIA members at a poll taken at the CIA bi-annual conference in 2009. It is envisaged that the recommended practices will be moulded into a totally integrated document under Rodney’s lead and, once accepted by the concrete industry, will become the de facto concrete durability code.

Acknowledgements

Although the task group chairmen were largely responsible for developing the recommended practices authorship was widespread and many have contributed to reviews. The CIA thanks the TG chairmen and members, other contributors, reviewers and all those that have contributed.