Challenges in the Conservation, Repair and Re-use of Historic Reinforced Concrete Buildings

David West and Donald Ellsmore

Title / Introduction

Introduce topic
- Going to outline some of the key challenges in conserving historic reinforced concrete buildings
- I’m not going to talk about particular buildings
Before I start, I’m going to take this opportunity to introduce to you the Association for Preservation Technology (APT).

Note that all of the international speakers here today are active members of APT.

Aims – to promote the best technology for conserving historic structures and their settings.

History – founded in Canada in 1968, as a joint US/Canadian organisation. Currently has over 1500 members, primarily in North America. More than 15 local chapters, including 2 international groups – Australasia and Latin America.

Activities – APT Bulletin – Annual conference – technical workshops
APT Australasia Chapter

Introduce APT Australasia Chapter.

Founded in 1989 by Donald Ellsmore
Formally constituted in 2004 by Donald Ellsmore, Bill Jordan and myself
Extended formally to cover all of Asia in 2010 – with the aim of fostering new members and groups of professionals in Asian countries to share in the knowledge and growth.

Our focus is on running technical workshops and seminars, generally in conjunction with other heritage organisations.
We also wish to promote networking and connections between professionals throughout Asia.
We run a website/blog to provide updates on activities.
Completely voluntary organisation.
Outline

I'm conscious this audience contains people who know a lot about concrete as well as people who know a lot about conservation. My aim is to help bring you all to better appreciate the complexity that arises when conserving concrete.

I am going to talk about the key challenges in conserving reinforced concrete buildings and structures.

I am going to explore questions of significance and authenticity, illustrated with examples.

I am going to outline a decision-making pathway, which has been cross-referenced to the Burra Charter, China Principles, Hoi An Protocols.

There is another key challenge, which is that of language. I am aware that whilst English has many specific terms for different approaches to conservation of buildings, Chinese (and I only speak Mandarin) is far more limited, using ‘baohu’ for conservation, and ‘zhuangxiu’ for refurbish or repair. So at times today, the translators may find it difficult to communicate my precise meaning.
Definitions

(All from Burra Charter)

Conservation (preservation): ALL the processes of looking after a place so as to retain its cultural significance

Maintenance: continuous protective care of the fabric and setting of a place; distinguished from repair (which involves restoration or reconstruction)

Preservation: (UK/Aust sense) maintaining the fabric of a place in its existing state and retarding deterioration

Restoration: returning the existing fabric of a place to a known earlier state by taking away additions or by reassembling existing material without introducing new material

Reconstruction: returning a place to a known earlier state; distinguished from restoration by the introduction of new material into the fabric

Adaptation: modifying a place to suit the existing use or a proposed use

Note that these distinctions are not really that important – what they do is help us appreciate there are alternative approaches – which have equal or varying validity

Complicated in this setting because it is my understanding that the Chinese language doesn’t have different concepts for each of these – limited to ‘baohu’ as an overall concept, and processes of ‘xiuli’ and ‘zhuangxiu’, to use the Mandarin terms.
Challenges

Functional

Structural

Technical

Cultural / Philosophical

Challenges

(discuss briefly but not in detail except where relevant to examples)

Functional

Structural

Technical

Cultural / Philosophical
Functional Challenges

Changing uses (e.g. factories, markets)

Changing requirements for space (e.g. apartments)

Greening of buildings (energy efficiency, reuse of materials/structure, sustainability) – keeping old fabric / buildings is one of the most sustainable ways of building.

Changing codes (fire safety, acoustics, energy efficiency) – design life vs performance capacity – these are not the same.

Changing expectations (waterproofness, appearance)
Structural Challenges

Brief introduction – I’m sure Tony Read will touch on some of these challenges in his presentation on the Central Market project later today.

Code change
- Dead / live loads
- Wind loads
- Seismic loads

Evaluation of capacity
- Lack of details
- Lack of knowledge – early concrete reinforcement systems were very different to those used today.
- Lack of ability to determine condition / capacity on buildings
- Lack of willingness to consider performance in use as justification of adequacy – there is a growing interest in developing ways of using past performance of existing buildings to establish capacity; this is being driven by researchers in the US, including John Ochsendorf and Robert Silman.

Need to certify code conformance

Loss of strength / capacity in use
- Weathering of concrete
- Corrosion of reinforcement
- Deflection of members

Loss of practical functionality
- Sagging of floor slabs
Technical Challenges

Deterioration mechanisms (understanding them)
- Carbonation of concrete
- Corrosion of reinforcement
- Alkali silicate reaction
- Erosion of surface matrix
- Soiling

Understanding condition
- Assessing
- Priority of mechanisms
- Future prognosis
- Effect on strength (and loading capacity)

Suitability of repair mechanisms

- Range of repair techniques
  - Patch
  - Replace reinforcement and patch
  - Coatings
  - Corrosion inhibitors
  - Anti-chloride treatments
  - Cathodic protection
  - Realkalisation
  - Chloride removal

- Impact on significance / authenticity

- Matching appearance
  - Colour
  - Texture
  - Finish – don’t forget that many early concrete buildings were painted and/or rendered
Cultural / Philosophical Challenges

I will talk about this in more detail shortly.

Understanding significance
- Material
- Finish / appearance
- Structural
- Functional
- Intangible (use, events, social)

Authenticity of conservation works
- Finish / appearance
- Material composition
- Construction detailing
- Structural capacity / action
- Function / use

Reversibility / Non-intervention

Make reference to Pamela Jerome’s presentation on the Guggenheim to follow
Industry ‘Best Practice’ – a limiting factor

We all see decisions through our frame of reference.

Much work on the repair of concrete buildings to date has been driven by the concrete repair ‘industry’, which seeks to promote the use of proprietary products and systems backed by warranties (of varying value).

The ‘industry’ tend to reject alternative approaches (“will cost much more”, “can’t do it”, “can’t give you a warranty for this”).

Another aspect to this is that decisions are often driven by engineers (structural, material condition, concrete as an engineering material). They are also limited by their obligations to conform with their code of ethics and with statutory codes: Structural adequacy / code conformance / certification

These two factors tend to limit the creativity of conservation solutions, and to have impact on the authenticity of the conserved structure.
Significance

... “the aesthetic, historic, scientific, social or spiritual value for past, present or future generations” ...

... “which is embodied in the place itself, its setting, use, associations, meanings, records, related places and related objects.”

Burra Charter article 1.2

Significance

Definition taken from Burra Charter / referenced in Hoi An Protocols

Increasingly accepted that an understanding and a set of decisions about what is significant and how it is embodied in a particular building is required before decisions can be made about the way in which a building is conserved.

Can be used as a set of standards to evaluate suitability of a proposed conservation approach, just as a structural loading code is used to evaluate compliance of the structural adequacy of a building.

Significance is however complicated by being more subjective, and having the ability for others to see significance differently.
Explore Significance

Taking a hypothetical concrete pier – which could be in Sydney, New York, Chicago or Hong Kong (in fact, these photos are from San Francisco)

Reasons for its historic significance could include:
- Last remaining example of a reinforced concrete pier
- Best example of its type of pier
- Pioneering use of reinforced concrete in piers
- First reinforced concrete pier in Asia
- Part of historic continuous ferry operations
- Opened by dignitary
- Wartime evacuations / battle
- Famous engineer / builder
- Other important person associated by visiting, naming, opening or other event
- Social significance as site for departure/arrivals of ferry across harbour

Implications of significance on conservation options:
- Materials
- Elements
- Structure
- Operation
- Existence
Significance

Explore Significance

If the following contributors to significance are considered most important, then implications for conservation could be:

- Last remaining example of a reinforced concrete pier
- Best example of its type of pier
- Pioneering use of reinforced concrete in piers
- First reinforced concrete pier in Asia

Could mean that the concrete itself is considered most significant, and therefore conservation should minimise modifications to concrete materials and elements
Significance

Explore Significance

If the following contributors to significance are considered most important, then implications for conservation could be:

- Part of historic continuous ferry operations
- Social significance as site for departure/arrivals of ferry across harbour

*Could mean that the use is considered most significant, and therefore conservation should involve strengthening and adaptation of pier to facilitate continued use as ferry pier.*
Significance

If the following contributors to significance are considered most important, then implications for conservation could be:

- Wartime evacuations / battle

*Could mean that tangible evidence of the war (bullet damage etc) is critical and must be preserved.*

I could go on – but in fact, there will usually be a combination of these scenarios acting. The challenge (and the opportunity) is for the stakeholders and decision-makers to work through these and identify the preferred solution.

Striving always to maintain significance and maximise authenticity within the community framework of demands and opportunities for ongoing use of the building.
Authenticity

... “the primary and essential condition of heritage”

Explore Authenticity

Authenticity:
- Difficult concept
- Many things to many people
- Varies depending on culture and context
- Essentially relates to ‘honesty’ – e.g. ‘truth to materials’ and ‘truth to structure’
- Original (materials, construction, function, use) valued – but priority does depend on significance
- Strive for authenticity rather than black/white – is authentic or is not authentic
Authenticity

Explore Authenticity

This matrix of dimensions of authenticity is taken from the Hoi An Protocols.

Considering concrete structures / buildings, key dimensions include:
- Appearance (e.g. retain original off-form finish, not painted)
- Composition (e.g. match original concrete mix for patches rather than using proprietary repair mortar)
- Method of construction (difficult to achieve … but would use similar spec reinforcement and avoid carbon fibre, for example)
- Method of carrying load – structural system (no additional structural supports that make existing concrete structure all or partially redundant)
- Use - original (or very similar) use

Fundamental problem with authenticity of materials in concrete buildings is the changing nature of Portland cement over the past 130 years … it is currently almost impossible to match the Portland cement used in a historic concrete building due to the changes in manufacture, and this is unlikely to change.
Decision Pathway

This decision pathway is a simplistic model of a fairly standard process, but is always good to be clear about the way we want to make decisions, and to remind ourselves of the need for process and iterative consideration of the wide range of issues.

1. Assess:
   - Construction
   - Structural adequacy
   - Condition
   - Feasibility (including market) for existing (or alternative) uses
   - Significance

2. Determine:
   - Code upgrades required
   - Structural upgrades required
   - Repair options
   - Functional upgrades required
   - Significance rankings

3. Consider impact of each upgrade / repair option against each aspect of significance (matrix often beneficial)

4. Test preferred option against:
   - Budget
   - Functionality
   - Significance – maintaining significance
   - Code upgrades – conformance
   - Repairs – sustainability of works and function (including durability)

5. Recommend preferred option

6. Test authenticity – look to maximise authenticity in each aspect of proposed conservation works

7. Decision
Summary

Go over key points:

• Frames of reference
• Language
• Significance
• Authenticity
• Considering all aspects
• Learning along the way
• Sharing the lessons
Selected Resources

Australia ICOMOS Burra Charter
The China Principles
Hoi An Protocols

Preservation Brief 15: Preservation of Historic Concrete, Paul Gaudette & Deborah Slaton, National Parks Service
The Investigation and Repair of Historic Concrete, NSW Heritage Office
Australian Building: A Cultural Investigation – Research Database, Professor Miles Lewis

APT Bulletin – multiple papers

Lewis, M. 1988, 200 Years of Concrete in Australia, Concrete Institute of Australia, Sydney.