Mt Pleasant Reservoir No. 1

Learnings from a Journey with an Aging Reservoir
Presentation Outline

— Background
  About the Reservoir
  Nature of Reservoir Construction
  Previous Repairs/ Refurbishment

— Recent Works
  What we knew
  What we didn’t know

— What we did to fix it
Mt Pleasant No. 1 Reservoir

— One of three ~18 ML reservoirs at the Mt Pleasant reservoir site
— Constructed 1960’s (No. 2 constructed in 1987 and No. 3 in 1999)
— ~50m diameter, 10m high
Mt Pleasant No. 1 Reservoir - Construction

- ‘Monier’ Type construction

- Internal monolithic, reinforced concrete wall (9 inches thick)

- Wrapped with varying layers of tensioning strands as ‘post tensioning’

- Covered with an external ‘shotcrete’ render layer
Mt Pleasant No. 1 Reservoir - Construction

All tensioning strands are 3.6 mm high tensile steel distributed as follows:

- Top third - single layer of strands with a density of 8 strands in 150 mm.
- Middle third - two layers of strands with a typical density of 20 strands per 150 mm.
- Bottom third - three layers of strands with a typical density of 30 strands per 150 mm.
Mt Pleasant No. 1 Reservoir - Construction
Mt Pleasant No. 1 Reservoir - Construction
Previous Problems and Repairs

— Cracks in external render identified in early 2000’s – injection grouting and re-painting with limited success
— Leaking through floor joints and seals – joints and seals replaced in 2015
— Horizontal cracking on reservoir inside wall - epoxy coat reservoir internally
New Problem

Problem: Delaminating External Render, exposing some post-tensioning wires

Investigations:

— Visual inspection;
— Non-destructive hammer tap survey;
— Non-destructive cover surveys;
— Concrete breakouts;
— Carbonation depth testing;
— Chloride content testing;
— Analysis of results
Solution – Original Scope

Solution: Capital project for External Refurbishment:

— Remove delaminated external render and injection repair material through hydro-blasting – 26% of area affected.
— Install embedded sacrificial anodes to existing tensioning wires.
— Reinstate external render with cementitious repair material.
— Install additional post-tensioned (PT) steel band and anchorage systems in place of corroded wire.
— Reseal the wall/roof joint using flexible water proof sealant.
— Apply a protective coating over the walls of the entire structure.
Original Scope

**Solution:** Capital project as per BC-16-04

**Tender:**
- Quantities - Degree of uncertainty recognised
- Provisional Quantities included in pricing schedule
- Tender schedules allowed for +- 50% on quantities, allowing up to 10 PT bands

- **Original Tender Price:** $1.4M
  - Lump sum component - $0.6 M
  - Remeasureable component - $0.8 M (based on tender quantities)
  - Estimated Contingency - $0.4 M (base on +50% on all PQ)

- **Original Tender Program:** Start by Late April, Completion by 31 August 2017
Emergent Challenges

Problem:
— Further areas of delamination found – now 54%
— Higher levels of corrosion to the wires than initially anticipated
— Relaxation of larger groups of wires with significant corrosion uncovered under the removed render
— Recoil of the wires back to their original coil diameter causing a prying force on the edge of the sound render
— Low adhesion of the render to the main concrete substrate underneath
Emergent Challenges

Solution: Reassess and change methodology

- Remove ALL Render and post tensioning wires
- Install sufficient PT bands to replace all post tensioning wires (84 required)
- No need to re-render, but painting system needs to protect now exposed concrete surface
- Cost and program implications
More Emergent Challenges

Problems:
- Some sections of render difficult to remove
- Rough finish of concrete – preparation required before painting
- Sections of concrete spalling and low reo cover (5 mm) in exposed reservoir wall

Options?
- Grind off rough/ sharp edges and patch spalled areas?
- Render exposed concrete surface (using materials already purchased and on site) to provide cover and patching of spalled sections?
- Apply fairing coat?
And there’s more!

Internal Inspection Revealed:

— Cracks at vertical construction joints
— Damage to internal coating at construction joints and ring beam join
— Due to estimated 20mm movement of reservoir
Final Solution

— Patch major (>10mm in depth) spalled sections using material on site
— Paint external walls - minimal preparation
— Install PT bands

— Fix the cracks in the internal coating using Hypalon bandage
Early Learnings

Consider assets holistically

Risk Assessment and reassessment

Project Team
— MRC Council and management support
— Specialist consultants - Structural engineering and materials technologies
— Flexible Head Contractor
— Specialist Sub-Contractors – PT Bands and Hypalon
— Product suppliers

Product Suppliers
— Suitable products change with methodology
— Difficult to balance timely procurement in evolving process
  procured products not always easily returnable
— Supplier Warranty Issues – product compatibility, surface preparation
  Need to engage with ‘preferred’ supplier from the outset
Thank you

Questions?