
Neil Street Car Park Structural Repairs

Ashlee Adams • 6/11/15
INTRODUCTION

The Building
• Constructed by Department of Transport, QLD in 1989;
• Ownership since transferred to TRC;
• Bus station on ground level which has Translink urban bus services and long distance services (Greyhound);
• Two car parking levels above.

History of Defects
• Council became aware of spalling issues in 2005 and implemented a repair and inspection program to address the issues;
• Two subsequent structural reports undertaken in June 2010 and March 2011;
• Some repair works undertaken to minimise spalling and to reseal expansion joints.

• The defects however were still apparent and not improving.
DEFECT INVESTIGATIONS

Visual Defects Include:

• Concrete spalling; and

• Water leaking through slip joint.
DEFECT INVESTIGATIONS

Visual Defects Include:

• Water ponding in multiple locations.
DEFECT INVESTIGATION

Have we addressed the symptoms or the cause?

• The previous investigations looked at the spalling only;

• Slab deflections were not investigated;

• All repairs were of a cosmetic nature;

• No structural integrity testing or destructive testing undertaken.

• As a result an internal structural investigation was commenced in 2013.

This included:
• A design check of the slabs in question;
• Concrete core samples and testing; and
• A structural inspection.
Conclusions of Internal Investigation:

- Based on current practices, the construction of the movement joint is fundamentally flawed, as it did not allow for rotations of the concrete slabs.

As new:  

After 10 years:  

Edge Failures:
DEFECT INVESTIGATION

Conclusions of Internal Investigation:

- Based on current practice, the design of the joint should have ensured that the corbel edge remained un-loaded even after rotations occurred.

As new:  

After rotation of slab:
DEFECT INVESTIGATION

Conclusions of Internal Investigation:

• Though the design met the relevant standard at that time, it does not appear to meet the current version of the Australian Standard (AS3600-2009);

• Design detailing has proven to have caused issues with slip joints;

• Average compressive strength of 25.54 MPa from concrete core samples. Design drawings state that concrete strength should be 32MPa;

• Theoretically the structure will not be able to handle the design loads; and

• Workmanship on the construction was sub-standard as evidenced by the: sub-strength concrete, carbonation depths, exposed tie-wires and poor bolt fixtures.
DEFECT INVESTIGATION

Conclusions of Internal Investigation:

• Recommendations:
  
  • Remove all loose materials from joints;
  
  • Install a metal catch tray for any future spalls;
  
  • Place load limit of 2.34 tonnes for entry to car park;
  
  • Undertake structural integrity testing; and
  
  • Design a permanent repair solution.
TEMPORARY MEASURES

Catch Trays at Joints

- Falling concrete from spalling areas considered public safety risk;
- Catchment trays were installed at the four slip joints;
- Trays have been left up to ensure current works stop spalling.
DEFECT INVESTIGATION

Structural Integrity Testing Undertaken:

• Integrity Testing Pty Ltd engaged to undertake load testing;
  • Mod-Shock Testing and DBTs;
  • Sample of beams, slabs and columns tested.

• The testing concluded that:
  • All the column and beam supports were serviceable and had sufficient Safe Additional loadings to support the building;
  • A number of concrete slabs are considerably below the load capacity required for a car park and are considered unsafe for this use;
  • Further testing undertaken yielded similar results but allowed for the determination of usable car parking spaces on this level.
STRUCTURAL RECTIFICATION DESIGN

Temporary Solution:

- Kehoe Myers were engaged to design both temporary and permanent repairs;
- Suspended slab capacity determined by Integrity Testing’s report was verified by a calculation check;
- Capacity was lower than the design load per the current standard;
- Line-marking layout was redesigned in under strength areas to redistribute the loads.
TEMPORARY SOLUTION

Reconfiguration of Parking

• Two areas on top level closed off completely to all traffic.

• The reconfiguration meant a total temporary loss of 62 car parking spaces;

• Parking availability in CBD a public concern.
STRUCTURAL RECTIFICATIONS

Options for Permanent Repair

• Kehoe Myers Consulting Engineers undertook a permanent repair design which would restore the remaining design life for the structure (~additional 25 years);

• Four options for permanent repair were considered;

<table>
<thead>
<tr>
<th>Repair Method</th>
<th>Budget Cost</th>
<th>Cost per Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>New car park on alternate site</td>
<td>$6.4M</td>
<td>$20,000</td>
</tr>
<tr>
<td>Steel structure on roof</td>
<td>$2.9M</td>
<td>$46,000</td>
</tr>
<tr>
<td>Carbon fibre strips</td>
<td>$1.6M</td>
<td>$25,500</td>
</tr>
<tr>
<td>Steel Beams</td>
<td>$1.7M</td>
<td>$27,000</td>
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</tbody>
</table>

• New car park and steel structure prohibitive in terms of cost; and

• Size of steel beam required would not leave sufficient head height for vehicles;

• Carbon Fibre strip repairs chosen as preferred method.
CONSTRUCTION

The Contractor:

• The contract was awarded to Freyssinet Australia in July 2015.

Scope of Work:

• Carbon Fibre FOREVA LFC strips to slabs and select beams;
• Slip joint replacement (Hercules HSC/1/150/30);
• Slip joint seal replacement (Miska ZealSeal);
• Patching of existing spalled areas; and
• Temporary relocation of two bus platforms to Neil St and Church St to facilitate works.
CONSTRUCTION

Carbon Fibre Installation

The process of installation:
- Mark out centre line location of strips on slab;
- Water blast the slab where strip will be placed;
- Cup grind any areas which require a better prepare surface;
- Paint epoxy onto clean strip; and
- Place strip on slab.
Carbon Fibre Installation

Design Layout:

• Same carbon fibre strip used in all locations;

• Spacing modified to reflect the amount of strengthening each slab required.
CONSTRUCTION

Quality Assurance:

Pull Off Testing:

• Once bonding agent is cured testing can begin (7 days);

• 25mm circular dolly is bonded to the laminate in the desired test location;

• A core hole is drilled around the dolly using a diamond core drill. Drill depth 6-12mm;

• The test apparatus is attached to the dolly and aligned to apply tension perpendicular to the concrete;
CONSTRUCTION

Quality Assurance:

Pull Off Testing

• Load is applied to the dolly until failure;

• For a successful test, the failure should always be in the concrete. Concrete failure indicates sufficient laminate bond; and

• The min. pull-off strength is 1.4Mpa with an average of 2.0Mpa over the test set.
CONSTRUCTION

Replacement of Slip Joints

Lifting slab off the beam:
• Lifting method utilised rather than a jacking method;
• Beams installed on roof slab across slab joint;
• Rods through cored holes in slabs;
• Hydraulic jacks used to lift beam at one end; and
• Required lift of approx 10mm.
CONSTRUCTION

Replacement of Slip Joints

- The existing joint was a single strip of tin and was not providing the slip required for the joint to function;
- The replacement Hercules HSC/1/150/30 is a better solution;
- Once slab is lifted existing joint is removed;
- Gap is water blasted and allowed to dry;
- New strip installed; and
- Slab lowered down.
Why a new seal?

• Significant water leaking issues present in all levels;
• Steel cover plates have previously been removed; and
• Miska ZealSeal considered a better solution.
CONSTRUCTION

Installation of Miska ZealSeal

• Significant water leaking issues present in all levels;

• Steel cover plates have previously been removed;

• Miska ZealSeal considered a more durable solution; and

• Easily adapted to a retrofit application.
CURRENT STATUS

• Carbon fibre work is complete;
• Slip joint replacement works complete;
• Miska ZealSeal joint sealing complete;
• Ramp corbel works this weekend;
• Bus area re-opening on 23rd November;
• Additional Miska Joint replacements being undertaken; and
• Car park due for to be returned to full capacity in early December.
QUESTIONS??

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