Investigating the correlation between pre- and post-demolition assessments for precast, post-tensioned beams in service for 45 years

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Torill Myra Papè
I dedicate this thesis to my loving and supportive husband Anton, who has put on hold his own dreams to allow me to follow mine.

I’m blessed to share this life with you.
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Finally, I give thanks to my God for the opportunity and my inspiration - through Him all things truly are possible.
Roads to Sorell

Welcome, to Van Diemans Land
you rogues that humble Britain, who finally made a stand,
to send you to Port Arthur upon the brink of hell
where on the road to Hobart is this little town Sorell.

Founded in the eighteen hundreds, Sorell cant ignore
the bushranger Matt Brady back in eighteen twenty-four,
when he stormed the settlement wreaking havoc on the law.
The most infamous bushranger, roads to Sorell ever saw.

Now the rogues have gone but their history lives today.
Milled wheat is just a memory for the folk up Sydney way.
Stone buildings dare the southerlies gusting up storm bay,
where we cross Pittwater Shallows on the Sorell Causeway.

The first Sorell bridge was built, back in eighteen seventy-two.
Eight years it took to build and many never seen it through,
for they became the bankrupts, and now that bridge has gone
where above sea stars and oyster farms, Sorell’s moving on.

Two years, two long years have passed.
This new Sorell causeway bridge is opened up at last
and McGees bridge to Hobart joins Sorell’s noted days
of bushranging convicts, and two ruined causeways.

Now the rogues have gone but their history lives today
Milled wheat is just a memory for the folk up Sydney way
Stone buildings dare the southerlies gusting up storm bay
Where we cross Pittwater Shallows on the Sorell Causeway.

Where we cross Pittwater Shallows on the Sorell Causeway.
Between Hobart and Port Arthur is this little town Sorell.

Author Unknown
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Abstract

The Sorell Causeway Bridge, located in Tasmania, Australia, was completed in 1957 and was the first precast, post-tensioned bridge constructed in Australia. However after only 45 years of service, the bridge was replaced due to increasing concerns surrounding the level of corrosion of the prestressing strands in the beams. Prior to its decommission, an extensive and costly investigation program was carried out on the bridge in an attempt to determine the rate of deterioration and establish the remaining margin of safety. Despite the number of investigations and the resulting large quantities of information, the questions surrounding the safety of the bridge remained unanswered. The issue is thus raised: what do field investigations of reinforced or prestressed concrete structures with evidence of corrosion deterioration tell engineers about the actual condition of the structure?

Three beams of varying condition (good, average, poor) were salvaged from the bridge demolition for further detailed examination to investigate the degree of correlation between pre-demolition field investigations and the physical condition of the steel post-demolition. The investigations included the use of conventional non-destructive techniques such as cover, half-cell potential and concrete resistivity surveys, and destructive techniques such as chloride profiling, carbonation depth measurement, and full-scale load testing, all of which were used to determine the likely risk of corrosion and likely corrosion rate for each beam. The results of these investigations were subsequently reviewed in relation to the physical condition of the steel.

In general, all non-destructive tests were found to be inconclusive in relation to evidence of steel corrosion and the corrosion risk guidelines recommended in the literature. It was also apparent that these techniques were incapable of detecting steel pitting, a primary concern for the current investigation. Chloride profiles were variable and inconsistent in relation to steel corrosion and
the chloride thresholds recommended in the literature. Carbonation was found to exist at prestressing levels in some locations and appeared to be influenced by the orientation and geometry of the beams. All beams did not achieve the estimated design capacity and corrosion had significantly impaired the ultimate capacity and ductility of beams in the worst condition.

Aerobic and anaerobic corrosion products were identified via XRD analysis. These included Magnetite, Goethite, Akaganeite, Lepidocrocite, chloride-based Green Rust (I), and Iron (III) Oxide Chloride. The phenomenon of “chloride weeping”, or droplets of highly acidic ferrous chloride, was observed forming on some steel/concrete interfaces on freshly cut concrete surfaces. Several other unexplainable observations were made during the course of the present investigations. These included bright, metallic pit surfaces; pits with concentric rings; black, wet rust covering bright, metallic surfaces; and unusual pitting profiles. A possible explanation for these observations may be the implication of microbiological activity in the corrosion process. Further research is required to confirm these observations.

**Keywords:** prestressed concrete, field investigations, corrosion, non destructive testing, concrete cover, half-cell potential, concrete resistivity, carbonation, chloride profiles, load test, flexural capacity, corrosion products, pitting, ferrous chloride, microbiological activity