Princess Pier, Torquay

Appendix to Capital Scheme Business Case: Princess Pier – Superstructure

A non-technical report primarily concerned with the condition and works need of the pier boardwalk.

Contents page

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Summary

The boardwalk widening at the end of Princess Pier (the 'Banjo'), and the timber landing adjacent are at critical risk of collapse. This report recommends their urgent controlled demolition; such collapse may otherwise compromise the integrity of the sea defence to which they are attached. Access to the concrete pier beyond the 'step' arising following removal of the widening may be returned with a ramped installation, subject to Planning consent.

Separately the steel frame supporting the boardwalk between the promenade at Princess Theatre and the widening requires treatment recommended to be passive cathodic protection to supporting piles/columns below the water line, and a high performance protective coating to framing above.

Introduction

The raised boardwalk constructed over the concrete sea defence in 1894 to extend pier use as a leisure facility comprises a steel frame supporting timber decking. It extends approximately 230m from the promenade at Princess Theatre and over sails the concrete pier seaward, to double the width of the underlying concrete surface.

The over sail is supported by steel piles, or columns, founded in the sea bed (see photo 2). The boardwalk widens further, both seaward and landward at the pier head (the 'Banjo'). An additional timber landing quay on the seaward side of the pier head was built in 1906.

1 Timber boardwalk at Princess Theatre promenade

2 1970s-installed galvanised steel frame below timber boardwalk supported on the original concrete and masonry pier, and by steel piles (columns)

3 Widening at the pier head; fencing installed in 2007 to close unsafe areas, thoroughfare maintained for public access to pier beyond

4 1950s-installed steel lattice supported widening stepping down to original concrete pier structure (photo taken before the 2007 closure). Both the steel lattice and the diagonal concrete encased steel props supporting it are severely defective

Current condition

Boardwalk widening

The condition of this area of the boardwalk is critically defective.

Original lattice steelwork support to the timber deck, including supporting piles, between the theatre and the pier head was replaced in the late 1970s with a galvanised steel frame; steel framing at the pier head, including its supporting piles, dates back to the 1950s and is severely defective due to prolonged exposure to the aggressive marine environment.

Since its partial closure on safety grounds in 2007 the condition of the widening at the pier head, and the adjacent timber landing, have continued to deteriorate. They are now both of a condition of potential collapse.

Reported in 2007 the steel piles supporting the lattice framed widening have been measured to be losing an average 1mm section thickness per year at the zone of 'Accelerated Low Water Corrosion' (ALWC). They were in the report estimated to lose all section thickness at this aggressive zone within 15 years. The piles currently therefore appear to be very close to failure. In addition their diagonal ties have in some cases already deteriorated to failure. ***The cumulative effect of severely weak piles and failed ties leaves the supporting***

members to the boardwalk widening as offering extremely uncertain structural stability.

Meanwhile the 1950s-installed steel lattice spanning over the piles and supporting the timber deck widening continues to similarly deteriorate, it having suffered complete loss of protective coating and having been exposed to the aggressive marine environment for many years. Severe section loss may be observed throughout the full lattice extent, where corrosion has left some elements with little residual structural capacity. The concrete-encased diagonal struts, redundant on the seaward side of the pier, but providing support to the harbour-side widening (see photo 4) display significant spalling i.e. bursting of the encasing concrete, maintaining the enclosed steel increasingly exposed to continuing corrosive action.

The timber landing adjacent to the widening displays complete or near-complete loss of section to several of its leg elements (see photo 9). Its stability in the marine environment is severely compromised with only residual strength and support in the remaining timber.

The close proximity of the uncertain timber landing and the uncertain steel pile array gives rise to the real prospect of potential consequential failure of either due to the collapse of the other.

5 Piled support to boardwalk widening showing failure of diagonal ties. The piles supporting the lattice framing have suffered accelerated low water corrosion (ALWC) and are severely corroded, having lost an average 1mm section thickness per year. The timber landing is to the right of the picture

6 General view below pier head widening showing corrosion to steel framing and significant spalling (cracking) of concrete encased props

7 Heavy corrosion to pier head steel lattice

8 Heavy corrosion to pier head steel lattice, showing delamination over residual steel section

9 Timber landing with significant reduction and complete loss of material to key supporting members

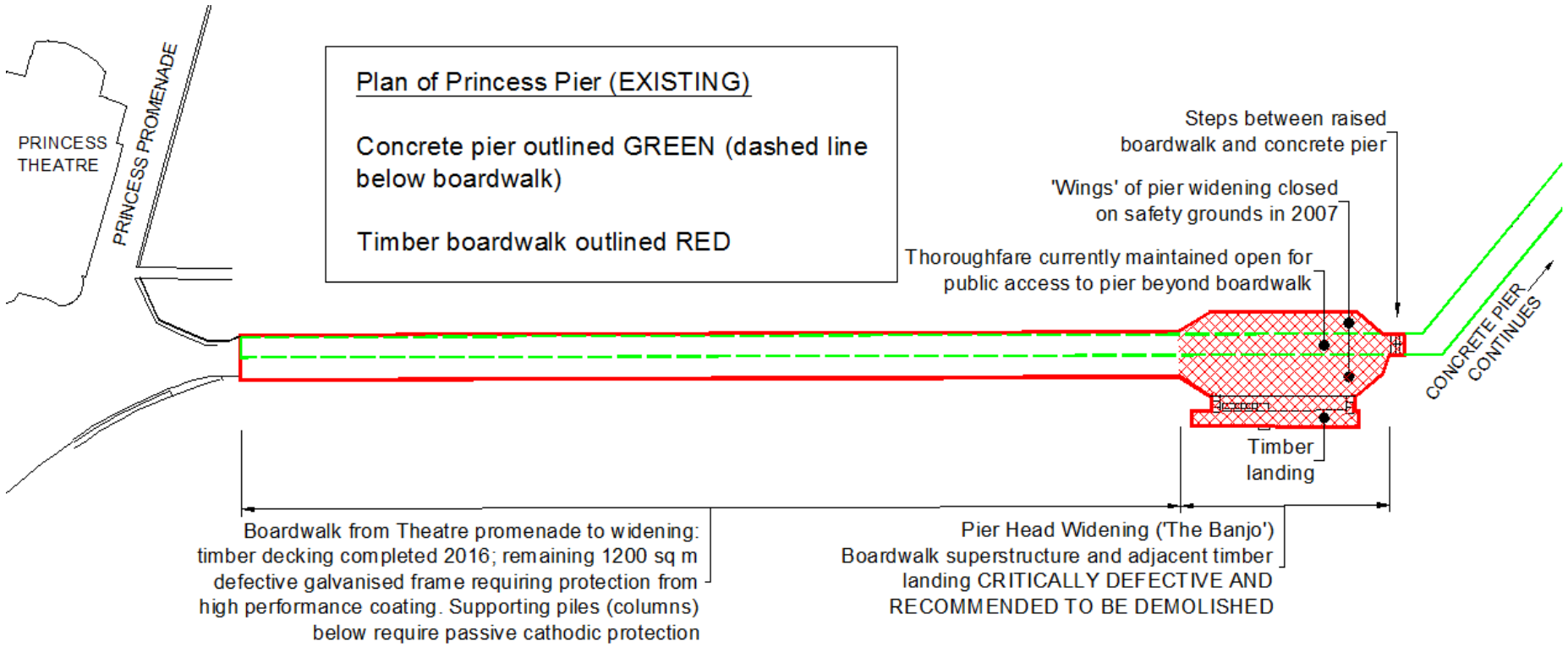
Boardwalk between theatre promenade and widening

Timber deck replacement to the length of pier from the theatre to the boardwalk widening, works spanning several years, was completed with a final 450m^2 in 2015/16. At the same time as this final phase the supporting galvanised steel frame was treated with a high performance protective coating system. The remaining 1200m^2 of 1970s galvanised framing remains untreated and shows loss of protective zinc plating appearing as localised areas of corrosion now susceptible to the marine environment.

The supporting piles to this section of the boardwalk have been previously treated with a protective coating now defective, the piles displaying localised corrosion, but remaining wholly functional.

10 View of failing galvanised protection to steel frame below boardwalk between theatre promenade and widening

11 View under boardwalk showing recent timber decking installation over 1970s-installed galvanised frame refurbished with protective coating


Plan of Princess Pier (EXISTING)
Concrete pier outlined GREEN (dashed line below boardwalk)
Timber boardwalk outlined RED
PRINCESS THEATRE
PRINCESS PROMENADE
Steps between raised boardwalk and concrete pier
'Wings' of pier widening closed on safety grounds in 2007
Thoroughfare currently maintained open for public access to pier beyond boardwalk
CONCRETE PIER CONTINUES
Timber landing
Boardwalk from Theatre promenade to widening: timber decking completed 2016; remaining 1200 sq m defective galvanised frame requiring protection from high performance coating. Supporting piles (columns) below require passive cathodic protection
Pier Head Widening ('The Banjo') Boardwalk superstructure and adjacent timber landing CRITICALLY DEFECTIVE AND RECOMMENDED TO BE DEMOLISHED

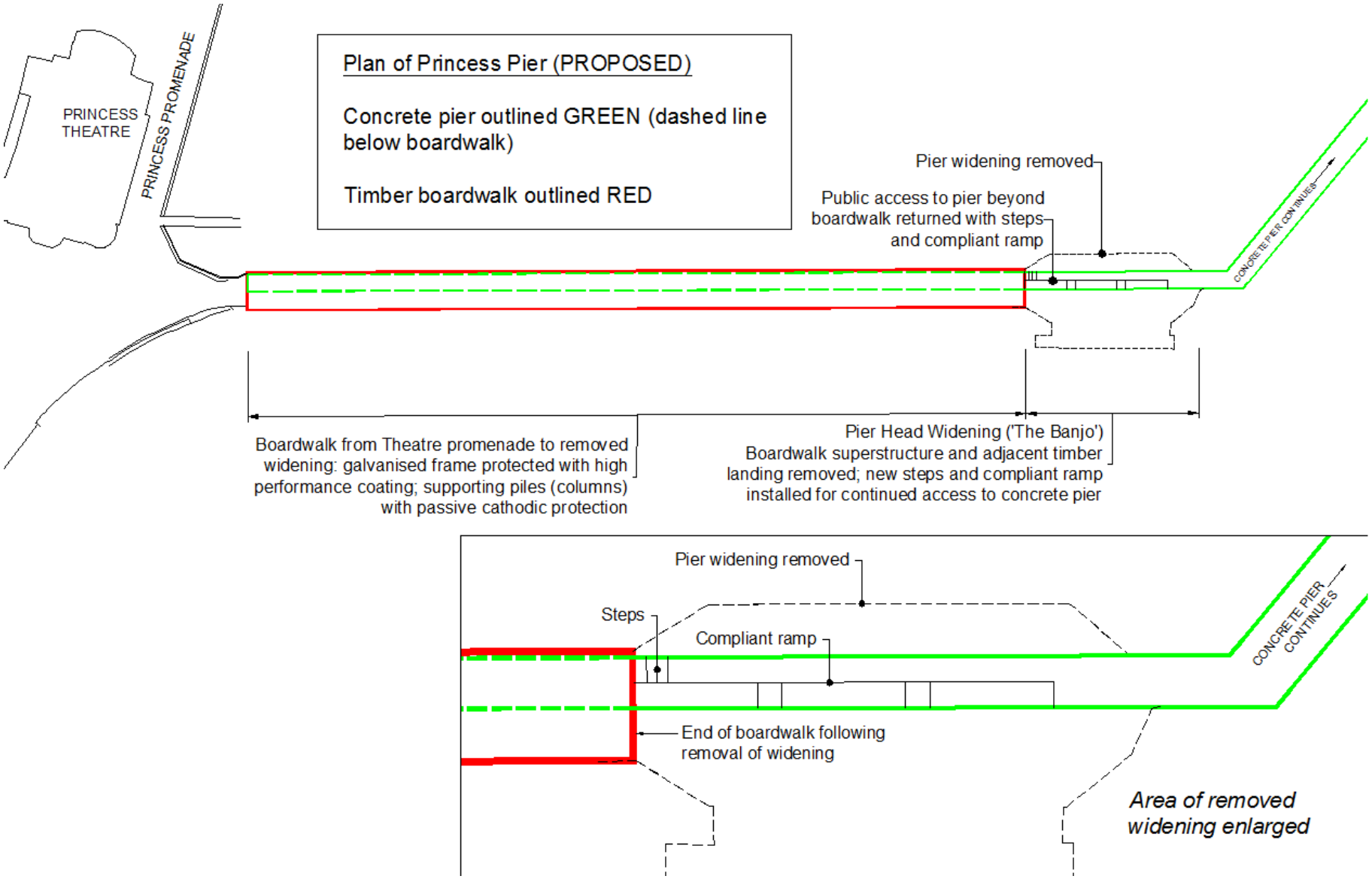
Conclusions and recommendations

The boardwalk widening at the end of the pier (the ‘Banjo’), and the timber landing adjacent are at critical risk of collapse. They are recommended to be urgently demolished under controlled conditions since such collapse may otherwise compromise the integrity of the sea defence to which they are attached. Access to the concrete pier beyond the ‘step’ arising following removal of the widening would be proposed to be returned with a ramped installation, as shown in the drawing below. Demolition and remedial step/ramp install are likely to be subject to Planning consent.

The galvanised steel frame supporting the boardwalk between the promenade at Princess Theatre and the widening has deteriorated to a condition requiring treatment recommended to be passive cathodic protection below the water line, and a high performance protective coating above.

Recommendations are illustrated in a drawing on the following page.

Note: There is an ongoing programme of underwater concreting repairs to the concrete pier subject to available funding, the highest priority works having been completed in 2017, to the pier structure beyond the boardwalk widening.


Plan of Princess Pier (PROPOSED)
Concrete pier outlined GREEN (dashed line below boardwalk)
Timber boardwalk outlined RED
PRINCESS THEATRE
PRINCESS PROMENADE
Pier widening removed
Public access to pier beyond boardwalk returned with steps and compliant ramp
CONCRETE PIER CONTINUES
Boardwalk from Theatre promenade to removed widening: galvanised frame protected with high performance coating; supporting piles (columns) with passive cathodic protection
Pier Head Widening ('The Banjo')
Boardwalk superstructure and adjacent timber landing removed; new steps and compliant ramp installed for continued access to concrete pier
Pier widening removed
Steps
Compliant ramp
CONCRETE PIER CONTINUES
End of boardwalk following removal of widening
Area of removed widening enlarged