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East Pier & West Pier Lighthouses, Whitby Harbour
INTRODUCTION

This report has been prepared at the request of Alan Dargue (Asset Management) following a report prepared by Steven Arrowsuch of the Historic Building Restoration Contractors, which highlighted issues relating to the central stair support to the West Pier Lighthouse, Whitby.

In addition to this, consideration is also given within this report to the recommendation made for the removal and subsequent replacement of the radial high level masonry straps to both the East and West Pier Lighthouses.

Inspections were made to the East Pier Lighthouse on 12th January 2012 and the West Pier Lighthouse on 23rd January 2012 and 1st February 2012.

This report is intended to record the general condition of the part structure as described above and to make any recommendations for remedial works, which we consider necessary.
**BACKGROUND**

**East Pier Lighthouse**

The lighthouse is situated on the East Pier, Whitby. It is a Grade II listed building and was built in 1854, most probably from locally sourced sandstone and stands around 17m in height.

The internal diameter at high level measures 1.65m with an external wall thickness of approximately 0.36m, giving an overall external diameter of 2.37m which gradually increases at ground level.

A timber spiral staircase provides access to an external circular, cantilevered stone balcony which projects past the face of the outer stone face of the structure by a distance of 0.88m.
BACKGROUND

East Pier Lighthouse

Eight wrought iron straps each measuring 30mm wide are set within the sandstone blocks and radiate around the internal circumference of the shaft at high level. The straps are set into the upper stonework course extending down by an alternating length of 1.7m and 1.4m respectively.
BACKGROUND

West Pier Lighthouse

The lighthouse is situated on the West Pier, Whitby. It is a Grade II listed building and was built in 1831, most probably from locally sourced sandstone and stands around 22m in height.

The internal diameter at high level measures 1.60m with an external wall thickness of approximately 0.4m (increasing to 0.6m at lower level), giving an overall external diameter of 2.4m which gradually increasing to a diameter of 2.8m at ground level.

A spiral staircase comprising of sandstone steps provides access to the upper most level. The steps have been topped and faced with a concrete screed approximately 50mm in thickness. Following repairs, the Lighthouse was opened to the public in 1947, it is possible that the present construction of the staircase dates from then.

Nothing of the original central supporting column remains, instead it has been replaced by a shuttered mass concrete column with an overall diameter of 270mm, a 50mm diameter mild steel conduit has been cast within the column.

An external square, cantilevered stone balcony extends past the face of the structure by a distance of 0.75m, increasing to 1.5m at the corners.
BACKGROUND

West Pier

Twelve wrought iron straps each measuring 35mm square are set within the sandstone blocks and radiate around the internal circumference of the shaft at high level. The straps are bolted through an annular metal plate which sits on the top block, extending down by an alternating length of 4.0m and 1.7m respectively.

Photograph 1 – Strap bolted through annular ring at top of lighthouse.
Photograph 2 – Anchor detail at bottom of strap.
Photograph 3 – Strap set into inner face of shaft.
BACKGROUND

West Pier Lighthouse
The central stair support comprises of a 270mm diameter circular mass concrete column which supports the inner face of each of the 81 steps. Mild steel handrails are cast into the column at regular centres over its full height.
INSPECTION

East Pier Lighthouse

Each of the internal radial straps were inspected. All were showing signs of surface corrosion and subsequent expansion of the metalwork was noted. Historic mortar repairs over the recessed strap have failed due to this expansion. At four strap locations, a vertical crack in the sandstone blocks extended beyond the end of the strap, although this was limited to a relatively short distance. Other longer internal vertical cracks were noted but these were positioned between the straps. Vertical cracks to the external elevation were noted and in general correlated with the position of the internal straps.

The bottom left hand side photograph shows failure of historic mortar repairs and vertical crack extending below the bottom level of the strap. The right hand side photograph shows the extent of vertical cracking to the external face of the sandstone stonework extending through nine, 0.44m high stone courses.
INSPECTION

West Pier Lighthouse
A number of the internal radial straps were inspected however it was not possible to assess all due to previous repairs which have covered the outer face. Of those inspected, signs of surface corrosion and subsequent expansion of the metalwork was noted. At two strap locations, diagonal cracking to either side of the anchor block, set within the sandstone was observed.
INSPECTION

West Pier Lighthouse
Severe near vertical cracking to the face of the central spiral staircase column at numerous locations were noted. The cracks are in the order of 10mm in width, beginning at ground floor level and extending up to step number 30 (about 7m in height). Further cracking of a similar nature is evident between steps 70 and 76.

The inspection involved the removal of a small section of the concrete column in order to expose the overall thickness of the encasement and expose any buried metalwork. It was noted that the column does not encase what is thought to be the original sandstone pillar, the column is simply mass concrete with a 50mm diameter conduit encased within its centre. The conduit carries cabling for the original lights and is corroded.

Additional information on the step construction was also taken. The steps, originally sandstone remain however, they have been topped and faced with concrete screed. This was most likely carried out at the time of the column work (circa 1940’s) and suggests that the treads are badly worn.
CONCLUSIONS

East Pier Lighthouse

Removal and subsequent replacement of the radial high level masonry straps –
There appears to be some correlation between the position of the straps and the vertical cracking to both the internal and external faces of the lighthouse. The cracking has been caused by the corrosion and subsequent expansion of the metal straps.

The straps play a vital role in the overall stability of the cantilevered balcony, providing a resistance to overturning of the upper stone blocks as a result of the cantilevered arrangement.

Serious consideration should be given to the possible detrimental results of simply replacing the straps without due consideration to the necessity of temporary propping of the balcony in the first instance. The residual cross sectional area of the straps are considered sufficient to provide an adequate resistance to the loads applied, however if the straps remain, further corrosion and expansion can be expected which will then continue to crack the stonework.

The balcony is not exhibiting any signs of excessive movement or instability as a result of the corroded straps, therefore it is not considered to be unsafe or in need of any temporary support in the immediate future.

It should also be noted that the various patterns of cracking to the fabric of the structure may well also be attributed to the gradual movement resulting in the prominent lean of the structure.
CONCLUSIONS

West Pier Lighthouse

Removal and subsequent replacement of the radial high level masonry straps –
Like the East Pier Lighthouse, the straps provide a resistance to overturning of the balcony structure. The conclusions made for the East Pier Lighthouse can also be taken as relevant for the West Pier Lighthouse.

Central stair support –
Whilst the steps are individually built into the outer wall and as such will be capable to a certain degree of cantilevering out, they are in part reliant on the central pier for support. This support is showing signs of complete failure due to a combination of the expansion of the centrally positioned corroded conduit and the weight transmitted through the column.

The staircase should be considered as unsafe to members of the public, although for the time being may be used by Council staff for maintenance purposes. There should be no more than two people allowed at any one time and under no circumstances should heavy equipment or materials be taken up staircase.
RECOMMENDATIONS

East Pier Lighthouse

Removal and subsequent replacement of the radial high level masonry straps –
At this stage the works should be no more than cutting a joint either side of the strap followed by the application of surface treatment to the metalwork such as wax oil. The joint should be cut to a width of no more than 5mm either side of the strap stopping short at either end by a distance of a single stone course. The material to be cut away should comprise only of the delaminated metalwork. In the first instance this should only be carried out on a single strap under the direct supervision of The Council's Principal Engineer and in consultation with the Council's Conservation Officer.

Other comments –
The building has experienced either settlement of its foundations or subsidence of the founding strata which has lead to the prominent lean of the structure. It is important that this movement and possible future movement is recorded and understood as it will enable The Council to make informed decisions not only on the viability of expenditure immediately required but also the long term viability of any works. Consideration should therefore be given to the installation of monitoring points enabling periodic measurements of the structures verticality to be taken. Monitoring will cost in the region of £250 per visit with a £500 start up cost for setting up the monitoring points and initial readings. Measurements should be taken every six months for the first year then annually (subject to readings).
RECOMMENDATIONS

West Pier Lighthouse

*Removal and subsequent replacement of the radial high level masonry straps* –
As with the East Pier Lighthouse, a joint should be cut either side of the strap
followed by the application of surface treatment to the metalwork such as wax oil.
The joint should be cut to a width of no more than 5mm either side of the strap.
Unlike the East Pier the joint can continue right to the underside of the annular plate
but must stop short at the bottom of the strap by two block courses. The material to
be cut away should comprise of no more than the delaminated metalwork. In the first
instance this work should only be carried out on a single strap under the direct
supervision of The Councils Principal Engineer and in consultation with the Council's
Conservation Officer.

*Central stair support* –
A repair option is limited if not impractical because unless the conduit is removed,
corrosion will continue leading to further expansion and deterioration of the column
support.
A temporary propping option will further reduce the already limited clear access
width which making access difficult.
 Ideally the column should be replaced in its entirety with all due consideration to the
listed status of the building however, it should be recognised that the disruption in
breaking out the column, given the eroded condition of the steps may well result in
additional works and increased repair costs.
An alternative would be to consider replacement of both the central column support
and steps. A specialist Contractor has estimated that costs for this work would be in
the region of £100k. The council's conservation Officer has advised that like for like
replacement will not require Listed Building consent but if there are alterations then
consent is likely to be needed.

*Other comments* –
As with the East Pier lighthouse, the building has experienced overall movement with
a prominent lean of the structure noted. It would seem sensible to include this
structure in the monitoring regime of the East Pier lighthouse. The quoted cost for the
East Pier Lighthouse can be considered to include both structures.
In addition to this, monitoring of the cracks to the central stair support should be
undertaken on a monthly basis. This could be carried out in-house by Harbour staff
with the initial monitoring set up being made by the Engineer.

LISTED BUILDING DESCRIPTIONS

East Pier Lighthouse
NZ 9011 5/428
Grade II

Built 1854. Stone column shorter than that of the West Pier Lighthouse
surmounted by lantern with leaded dome. Now disused.

Listing NGR: NZ9001311721

West Pier Lighthouse
NZ 8911 4/6
Grade II

Built 1831 from the design of Mr Francis Pickernell, the engineer to the
Harbour Trustees. Consists of fluted Doric columns surmounted by an
octagonal lantern (glazed on the seawards elevation) with octagonal lead
dome and vane. Rails round lantern. Visited by Princess Victoria in 1834.

Listing NGR: NZ8994311722

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Martin Lloyd
B.Eng. (Hons), C.Eng., M.I.Struct.E.
for and on behalf of Scarborough Borough Council
13th February 2012