Robin Hoods Bay Seawall PAR

Options Technical Report

February 2017

Scarborough Borough Council

Mott MacDonald

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Issue and revision record

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A	August 2015	Lucy Wiggins	Nick Clarke	Peter Phipps	
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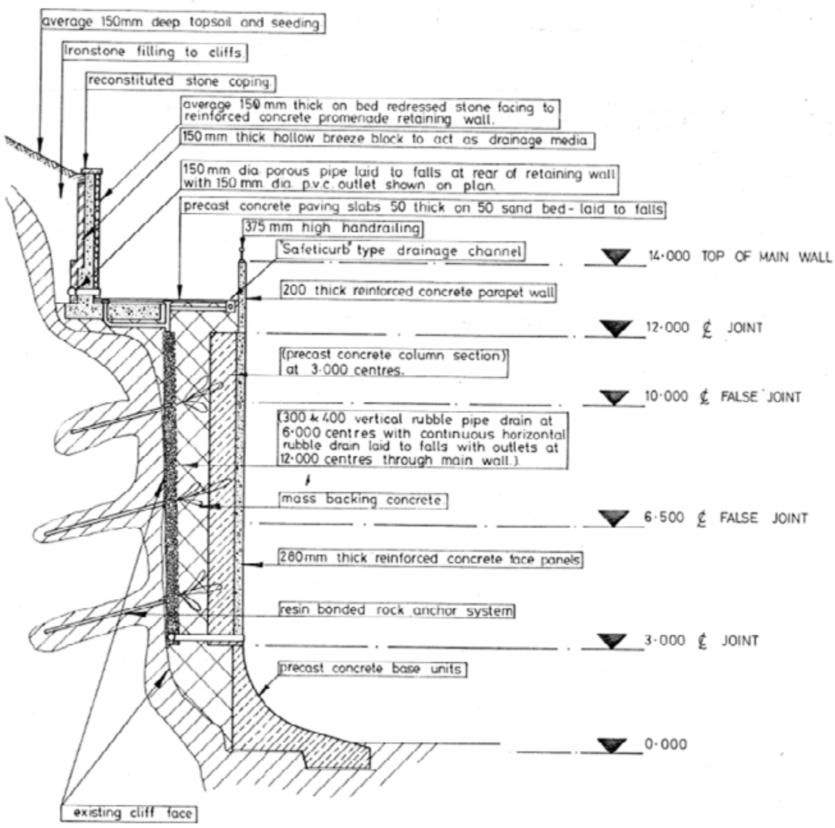
1 Introduction

This report provides a technical description for each of the shortlisted options for capital works maintenance of the seawall at Robin Hoods Bay.

The seawall at Robin Hoods Bay consists of a 160m long, 12-14m high, concrete wall. The visible columns were installed over curved foundation blocks, all being pre-cast. Once the columns were installed then reinforced panels were cast in between to act as a formwork for mass concrete infill between the wall and the wall. The wall construction was completed in the 1974. Considering the form of construction, the materials technology at construction and the exposure of the structure it is considered that the structure is nearing the end of its design life within the next 10-20 years. However, it is well known for structures to exceed their design life provided structural defects are corrected during maintenance. Following a visual condition assessment (Mott MacDonald, 2014) the wall was estimated to have a residual life of approximately 10 years under the existing (minimal) maintenance scenario. The residual life assessment is based on the evidence of a number of defects. The concrete is visibly deteriorating in places and there are visible signs of corrosion of the reinforcement in the facing of the wall which is causing cracking and spalling. The spalling concrete is a health and safety concern as it has the potential to harm beach users on the beach at the toe of the wall.

Figure 1.1: Typical cross section through the current seawall



Source: Construction drawing provided by Scarborough Borough Council, John H. Haste and Partners (1974)

In order to prolong the residual life of the structure capital maintenance and on-going management is required in order to address the defects that are occurring, in particular those that also are a health and safety risk. A short list of feasible options has been developed from the consideration of a longer list of potential options.

1.1 Structure of this report

In order to assess the technical requirements of each of the Do Something options this report has been divided into 3 sections. Each section will assess one of the shortlisted options:

- Patch repairs and installation of galvanised anodes;
- Replacement of the front panels of the wall and galvanised anodes; and
- Full replacement of the mass concrete casing that surrounds the mass concrete.

To allow a thorough understanding of each of the options and the capital works that will be required each section will assess the following criteria:

- Description of the works proposed;
- Outline the materials that are proposed in the works;
- Assessment of the health and safety risks;
- High Level Phasing / Programme of the works.

2 Option 2: Patch repairs and galvanised anodes

2.1 Works Proposed

This option focuses on repairing the face of the concrete wall to reduce the health and safety risk of spalling concrete. Patches of poor concrete would be repaired with the installation of anodes. Works to the existing drainage would also be undertaken to reduce residual risk of groundwater levels increasing behind the wall.

2.1.1 Wall Face

Areas of poor condition concrete would be identified visually and through concrete testing during site investigations. Areas would be prioritised to address those posing most risk of spalling first. Areas to be repaired would require the existing concrete to be broken out to expose the reinforcement and allow for replacement. Once the reinforcement is replaced sacrificial galvanic anodes would be installed to the reinforcement. The anodes will provide passive protection to the repaired area, reducing susceptibility to future corrosion and also to mitigate corrosion in surrounding existing reinforcement. An appropriate concrete repair mortar would then be utilised to replace the concrete matrix.

Visually this option will provide an irregular pattern of repairs, however given the existing variation and visible defects this is not considered to be significant.

2.1.2 Drainage

The vertical rubble drains will be capped to prevent surface water entering any voids behind the wall, to reduce any addition of water to the groundwater table.

The existing ‘safeticurb’ drainage will be cleared and cleaned out to ensure that the promenade is able to drain effectively through the high level drainage outfalls that discharge out through the sea wall.

Low level drains would be cleared of debris to determine if they can be reactivated as currently they are of low or no operation.

2.2 Materials Proposed

2.2.1 Wall Face

The concrete patch repairs will be undertaken using marine grade concrete, or an equivalent polymeric repair mortar. Zinc galvanised anodes (e.g. Sika Galvanised XP4) will be installed around the patch repair, at a max spacing of 400mm, depending on the size and shape of the repair patch.

2.2.2 Drainage

The vertical rubble drains will be capped using a plastic drain cover and blinding concrete to prevent the infiltration of water.

2.3 Risks

2.3.1 Health and Safety

The key health and safety risks to be considered and mitigated during the design and undertaking of the works include:

- Tidal working - particularly in relation to the potential for scaffolding and limited access to and from the beach.
- Working from height - with significant fall height >10m and potentially over water.
- Difficult access at height - Potential method of working requiring abseiling, mobile platforms, static platforms in the marine environment.
- Risk of spalling/debris concrete to workers and the public.

2.3.2 Residual Risks

This option does not address the rock anchors which have not been able to be tested as they are embedded within the mass concrete behind the columns. Testing of these anchors is not feasible without removal of a significant section of the existing wall, initially to confirm the anchor location, but also to perform a pull out test which would require exposure of the wall/cliff interface. This residual risk would be present until Year 40, when the proposed replacement of the seawall would address this risk. Should movement of the wall be identified during monitoring/maintenance then future options could consider the installation of new rock anchors. This could be achieved by coring through the existing seawall and mass concrete infill as well as into the cliff behind.

If clearing the low level drains of debris does not reactivate them, it could be considered to core the drains to take them back to the cliff wall interface. However, it is unknown if this would reactivate the drainage flowpath.

2.4 High Level Phasing / Programme of Works

The provision of patch repairs would be undertaken in phases as outlined in Table 2.1. This is to address initial priority areas, but also to provide ongoing maintenance and repairs. The phasing also recognises that continued patching will not ultimately prevent the structure deteriorating and that full replacement is likely to be required in the future.

During each phase of patch repairs the volume of repair would require to be assessed to ensure that priority areas are addressed. It is possible that repaired areas will also degrade between repair phases owing to the aggressive marine environment.

Table 2.1: The proposed programme for capital works for the Patch Repair Option

Year	Works
1	▪ Patch repairs to the concrete face and installation of galvanised anodes. Initial drainage works.
10	▪ Patch repairs to the concrete face and installation of galvanised anodes.
25	▪ Patch repairs to the concrete face and installation of galvanised anodes.
40	▪ Full replacement of the pre-cast seawall facing.

The phasing above recognises that patch repairs to the in-situ cast panels could continue until Year 40 when it is likely that the continued deterioration of the structure will require a full replacement. See Section 4 for details of the full replacement.

It is estimated that each phase of the repair works would be complete within 2-3 months depending on the Contractors methodology for undertaking the works, access arrangements, and weather restrictions.

3 Option 3 and 5: Replacement of concrete panels and galvanised anode

3.1 Works Proposed

Options 3 and 5 propose to repair the seawall by replacing complete panels of the existing wall. This approach provides a more robust repair and will provide a phased improvement to the seawall as well as reducing health and safety risks associated with spalling concrete. Poor condition panels of concrete would be repaired with the installation of anodes. Works to the existing drainage would also be undertaken to reduce residual risk of groundwater levels increasing behind the wall.

3.1.1 Wall Face

Information from visual and site assessments would identify the in-situ panels which are in worst condition. Entire panels would be broken out to form a complete square void that could then have a reinforcement replaced. Replacing entire panels allows for a better interface with non-repaired concrete to be achieved and removes a significant volume of the existing concrete. Sacrificial galvanic anodes would be installed around the perimeter of the removed panel to protect the interface between the new repair and the existing concrete panels which is typically susceptible to deterioration. Panels would then be infilled with an appropriate concrete repair mortar.

3.1.2 Promenade Drainage

The vertical rubble drains will be capped to prevent surface water entering any voids behind the wall, to reduce any addition of water to the groundwater table.

The existing 'safeticurb' drainage will be cleared and cleaned out to ensure that the promenade is able to drain effectively through the high level drainage outfalls that discharge out through the sea wall.

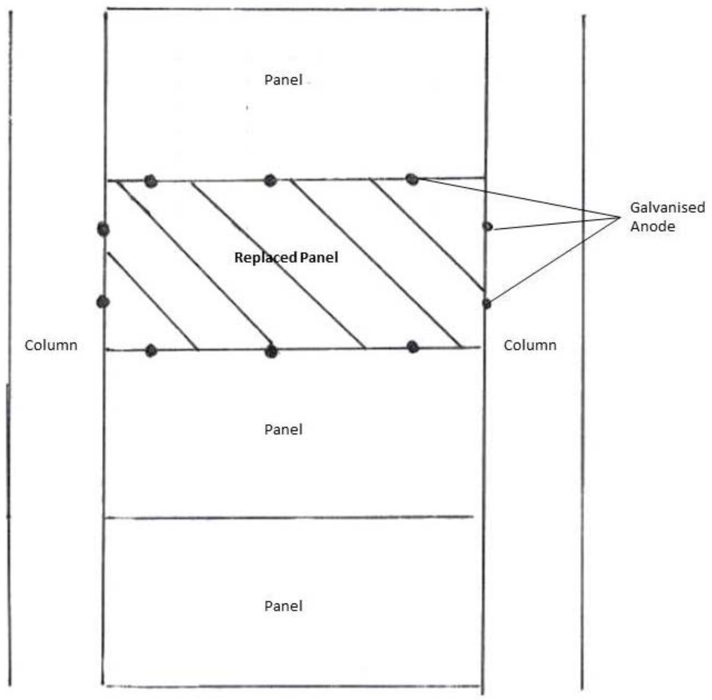
Low level drains would be cleared of debris to determine if they can be reactivated as currently they are of low or no operation.

3.2 Materials Proposed

3.2.1 Wall Face

The concrete patch repairs will be undertaken using marine grade concrete, or an equivalent polymeric repair mortar. Zinc galvanised anodes (e.g. Sika Galvanised XP4) will be installed around the panel repair, at a max spacing of 400mm (Refer to the Figure 3.1 below).

Figure 3.1: Schematic Panel Repair showing layout of the galvanised anodes



3.2.2 Promenade Drainage

The vertical rubble drains will be capped using a plastic drain cover and blinding concrete to prevent the infiltration of water.

3.3 Risks

3.3.1 Health and Safety

The key health and safety risks to be considered and mitigated during the design and undertaking of the works include:

- Tidal working - particularly in relation to the potential for scaffolding and limited access to and from the beach.
- Working from height - with significant fall height >10m and potentially over water.
- Difficult access at height - Potential method of working requiring abseiling, mobile platforms, static platforms in the marine environment.
- Risk of spalling/debris concrete to workers and the public.

3.3.2 Residual Risks

This option does not address the rock anchors which have not been able to be tested as they are embedded within the mass concrete behind the columns. Testing of these anchors is not feasible without removal of a significant section of the existing wall, initially to confirm the anchor location, but also to perform a pull out test which would require exposure of the wall/cliff interface. This residual risk would be present until Year 40, when the proposed replacement of the seawall would address this risk. Should movement of the wall be identified during monitoring/maintenance then future options could consider the installation of new rock anchors. This could be achieved by coring through the existing seawall and mass concrete infill as well as into the cliff behind.

If clearing the low level drains of debris does not reactivate them, it could be considered to core the drains to take them back to the cliff wall interface. However, it is unknown if this would reactivate the drainage flowpath.

3.4 High Level Phasing / Programme of Works

The provision of panel repairs would be undertaken in phases as outlined in Table 3.1. This is to address initial priority panels and provide ongoing maintenance and repairs. The phasing also recognises that continued patching will not ultimately prevent the structure deteriorating and that full replacement is likely to be required in the future. However, the replacement of the panels will ultimately prolong the residual life of the structure, and address health and safety concerns from spalling concrete.

During each phase of patch repairs the volume of repair would require to be assessed to ensure that priority areas are addressed. It is possible that repaired panels will also degrade between repair phases owing to the aggressive marine environment, however the replacement of entire panels reduces this risk as it allows a more comprehensive and robust repair.

Table 3.1: The proposed programme for capital works for the Patch Repair Option

Year	Works
1	▪ Replacement of concrete panels and installation of galvanised cathodes. Initial drainage works.
10	▪ Replacement of concrete panels and installation of galvanised cathodes.
25	▪ Replacement of concrete panels and installation of galvanised cathodes.
40	▪ Replacement of concrete panels and installation of galvanised cathodes.
55	▪ OPTION 3 ONLY - Full replacement of the pre-cast seawall facing.

The phasing above recognises that replacing the panels could continue until Year 55 when it is likely that the continued deterioration of the structure will require a full replacement. See Section 4 for details of the full replacement.

It is estimated that each phase of the repair works would be complete within 3-4 months depending on the Contractors methodology for undertaking the works, access arrangements, and weather restrictions.

4 Option 4: Full replacement of concrete casing

4.1 Works Proposed

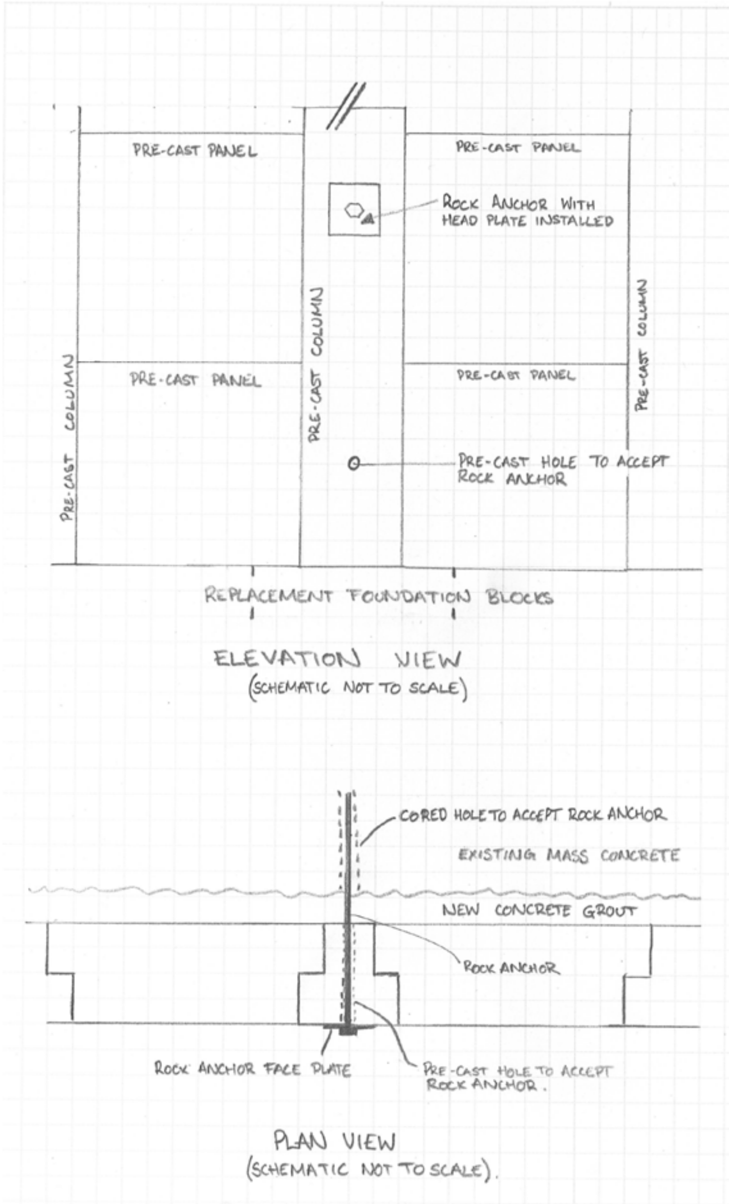
The full replacement of the concrete casing of the seawall is the most robust option and addresses all the current and residual risks. Designed to modern codes and standards of construction this option would provide long-term protection. Implementation of this option is technically more difficult to achieve and has risks that require management during the construction phase.

4.1.1 Wall

This option would require the removal of the existing concrete panels and columns and is likely to be required to be done in short-term phases. The existing mass concrete would also be cut back (not removed completely as this would risk exposing the cliff-face which is unknown condition) to provide enough depth for the replacement wall to be installed on top of the replacement foundation blocks. Once cut back and being faithful to the existing design, a series of interlocking pre-cast columns and panels would be installed. The advantage of the precast columns and panels would be the quality of concrete that could be achieved, increasing the durability of the seawall. New rock anchors would be installed by coring through the remaining mass concrete in order to tie the precast pillars back to the cliff, preventing forward movement of the wall. Columns would be designed wide then the existing such that the rock anchors pass through them with a face pate allowing future testing.

A new parapet wall would be incorporated within the replacement design. This would also include a replacement of the existing promenade area. The promenade area would be sealed using concrete to prevent water ingress to the rear of the cliff, a suitable drainage system would be provided to allow drainage of surface water from the promenade directly to sea.

Figure 4.1: Schematic of the Full Wall Replacement



4.2 Materials Proposed

4.2.1 Wall

The reinforced concrete facing wall would be constructed offsite (precast) and then installed as a system of columns and panels. This would increase the durability of the seawall as the concrete columns and panels could be cast in controlled environment. This form of construction would also reduce the materials handling on-site which has restricted access and working areas.

4.3 Risks

4.3.1 Health and Safety

The key health and safety risks to be considered and mitigated during the design and undertaking of the works include:

- The key risks relate to the temporary state during construction where sections of the existing wall are removed to allow the installation of the new wall. Both the design and the Contractor's methodology will need to consider the risks of the temporary situation and the potential destabilisation that this may create.
- Tidal working - particularly in relation to the potential for scaffolding and limited access to and from the beach.
- Working from height - with significant fall height >10m and potentially over water.
- Difficult access at height - Potential method of working requiring abseiling, mobile platforms, static platforms in the marine environment.
- Risk of spalling/debris concrete to workers and the public during demolition works.

4.3.2 Residual Risks

This option would address all of the residual risks.

4.4 High Level Phasing / Programme of Works

The provision of full replacement would not require a phased approach as it would provide long-term protection once installed.

Works on-site would need to be conducted in a phased manner to ensure that continued protection was provided to the cliff and that the risk of destabilising the wall is minimised. Works on-site for this option are estimated to take approximately 12 months to complete depending on the Contractors methodology for undertaking the works, access arrangements, and weather restrictions.