Technical Note

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Project title	South West Rail Resilience Programme: Colonnade to Coastguards	Job number	270561-00
cc	NR:[redacted]	File reference	142630-ARP-BRF-ECV-000005
Prepared by	[redacted]	Date	21 April 2020
Subject	Offshore breakwaters along the whole frontage RV01		

The Feasibility Comparison Report (142630-ARP-REP-ECV-000022) considered rock detached defences (or offshore breakwaters) as one of eight long list options for the frontage in general. This option was recommended as one of 3 options to be taken forward to optioneering for sections A, B and C. For Section D (most of the frontage length), a detached rock defence ranked six out of the eight options considered and therefore was not taken forward to optioneering.

This ranking and decision was made by considering the following (this is a summary of the Feasibility Comparison Report, D5) for offshore breakwaters:

- Can be designed to meet rail operational and passenger resilience requirements.
- Would not provide resilience to the pedestrians on the promenade.
- High capital cost (however costing had not been undertaken at this stage).
- Life cycle cost – maintenance would be required after extreme events and this would need to be undertaken with marine plant which could be costly, regular maintenance of the promenade (removal of shingle and sand) would be required.
- Buildability – railway service would not be affected by the works but requires significant working over water on an exposed site but minimal disruption to beach and public area.
- Programme duration and ability to meet project deadlines – outside the Network Rail permitted development boundary and therefore further consent would be required
- Visual impact & heritage preservation – negative impact on views from the shore and sea.
- Provision of enhanced public realm – creates sheltered area for swimming but public would not have access to the structure.
- Provides flexibility to meet accessibility requirements for SW Coastal Path and for Dawlish Station (AfA) but there are H&S risks associated with people climbing on the breakwater and possible rip currents between the detached rubble mound breakwater and existing structures.

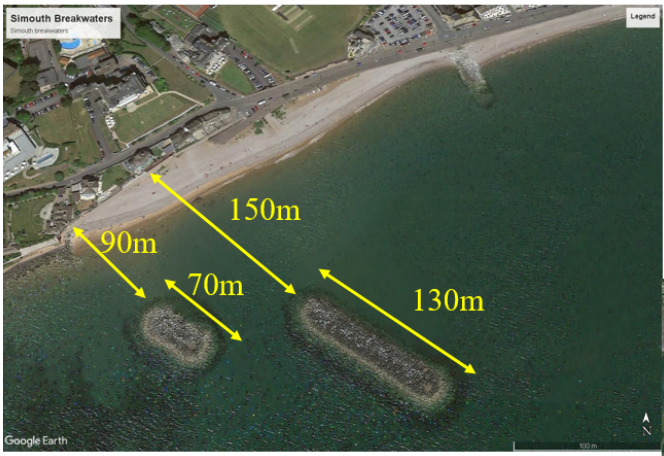
- Higher capital carbon impact from embodied emissions in materials and construction activities than other options.
- Environmental and bio-diversity – loss of Saballeria Reef habitat but conversely could provide a substrate for other intertidal biotope species.

This note expands on the Feasibility Comparison Report to further justify why offshore breakwaters have not been adopted as the solution for the whole Colonnade to Coastguards frontage.

Offshore breakwaters are usually adopted to protect a harbour, anchorage or mooring areas and as an erosion mitigation and shoreline stabilisation/protection measure:

- To protect a basin or area of shoreline from waves, breakwaters are designed to reflect or dissipate wave energy and thus prevent or reduce wave action in the protected area. An example of this use is Plymouth breakwater which aims to reduce the wave height and overtopping rates along the Plymouth coastline, resulting in less erosive forces on the coastline.
- As a beach erosion mitigation structure, the breakwater reduces the amount of wave energy reaching a protected area. The reduction of wave energy slows the littoral drift, produces sediment deposition and a shoreline bulge or salient feature in the sheltered area behind the breakwater. As a consequence, increasing the width of sediment buffer zone between land and the sea besides its erosion mitigation structure, translates into storm damage reduction. This is flooding and wave damage reduction. An example of this use is Sidmouth breakwaters where the breakwater was designed to keep the beach in place; with the beach providing resilience against wave overtopping.

Sidmouth breakwaters



Plymouth breakwater

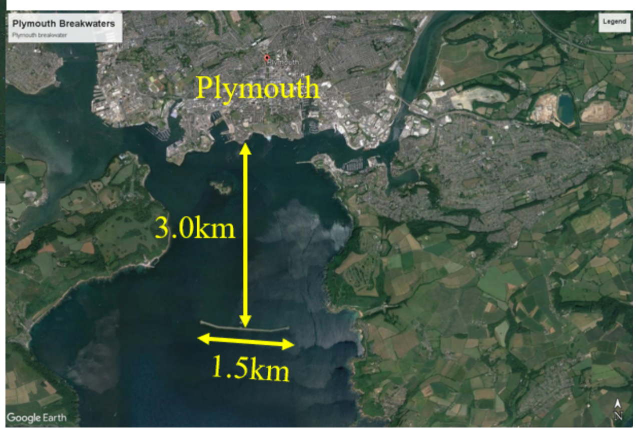


Figure 1 Example of offshore breakwaters in UK

Considering each of these examples, Plymouth bay is an enclosed bay and 1.5km of breakwater reduces the wave energy over a much longer length of coastline. The breakwater also has multiple benefits; one being coastal protection and others such as creating the appropriate environment for marinas, the harbour, etc. In contrast, Dawlish Bay is an exposed open sea site with a relatively linear coastline and therefore, in order to reduce the wave activity at the coastline, the breakwater would need to be of similar length to the bay (of the order of 2.5 to 3.0 km in length). The capital cost of building a breakwater of this length and the associated significant works to the existing seawall to deal with asset deterioration and the required platform upgrade (to meet current standards) is very high and prohibitive for Network Rail. Network Rail's primary aim with this solution would be to protect 3km of railway (aside from MP being already under construction). Based on this, the cost-benefit ratio of this solution makes it unfeasible. It is noted that this solution could have other benefits to Dawlish Bay area such as slowing down currently on-going erosion rates, providing flood resilience to Dawlish town and protecting the coastal ecosystem of the bay amongst others.

In the Sidmouth example, where the breakwater is used as an erosion mitigation measure, the overtopping resilience is achieved by relying on having a suitable beach in front of the existing structure. A solution similar to Sidmouth breakwaters along C2C frontage would help to maintain the beach levels to a certain level. However, some form of nourishment works during or after storm events would still be required. Arup developed a Beach Management TN (142630-ARP-BRF-ECV-000003) which outlines the risks associated to relying on a dynamic beach to provide resilience to a linear asset (such as it is the railway) and why any option that requires beach nourishment works has been discounted.

As part of the Feasibility Stage, Arup looked at feasibility to build an offshore breakwater close to the shore to reduce the wave energy reaching the coastline. Further outline design work has been completed on an offshore breakwater solution since the Feasibility Comparison Report. Two breakwater designs have been considered:

- High breakwaters – approximately 80m offshore with a crest level of approximately +7mAOD with some works to ensure long term stability of the existing railway retaining sea walls;
- Low breakwaters and sea wall or beach – a breakwater approximately 80m offshore with a crest level of approximately +4mAOD with new sea wall or beach in front to provide resilience to the railway.

The low breakwater option has been discounted due to the cost impact (capital and ongoing maintenance) of providing two significant separate structures (new breakwater and new seawall).

Therefore, a high breakwater design as shown below is considered further. This design shows relatively small gaps between the breakwaters to limit wave diffraction and the risk of resilience not being met at the railway at these locations.

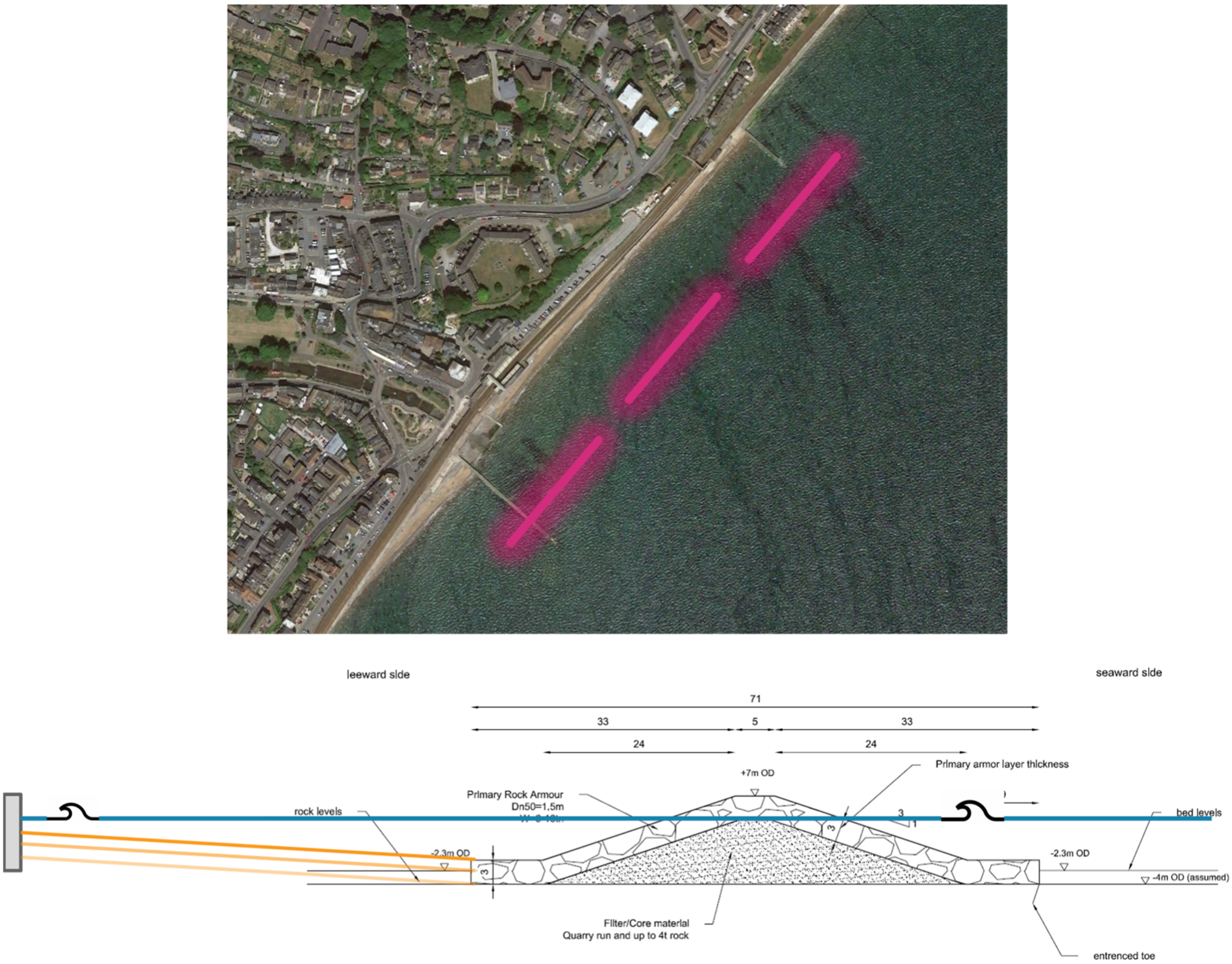


Figure 2 Example plan and cross section of offshore breakwater at Dawlish

A budget costing exercise has been undertaken by BAM for a high breakwater cross section as shown above for a 130m length. A budget cost of £19m was estimated with an approximate 12-month construction programme. To protect the entire C2C frontage, three breakwaters of this design would be required with a total volume of rock of approximately 250,000m^3 and a budget cost up to £57m. This cost does not include works to ensure long term stability of the existing railway retaining sea walls and ancillary structures (e.g. platform overhang) which would necessitate additional costs.

In summary, the following points further explain why this solution has not been considered further:

- The breakwater will help to maintain the beach levels. However, beach nourishment works may be required during and after storm events. NR is not able to commit to beach nourishment (refer to Beach Management TN 142630-ARP-BRF-ECV-000003) and therefore, there is a risk that the overtopping resilience of the railway is compromised which is not acceptable.
- The breakwater will help to maintain the beach levels at C2C providing amenity benefit and improved resilience. However, the beach is dynamic and cannot guarantee continuous resilience of the railway. NR are unable to fund significant amenity improvement works if they do not have benefits of providing resilience to the railway.
- In addition to building the offshore breakwaters, extensive works to 200m of platform would still be required as part of a platform upgrade in order to meet current standards.
- Offshore breakwaters have a higher capital and lifecycle costs than other options. The capital costs are very high, and breakwaters require maintenance necessitating marine plant.
- Risks of resilience not being met where waves diffract through the gaps between breakwaters.
- Significant negative visual impact of high breakwater on views from the shore and sea.

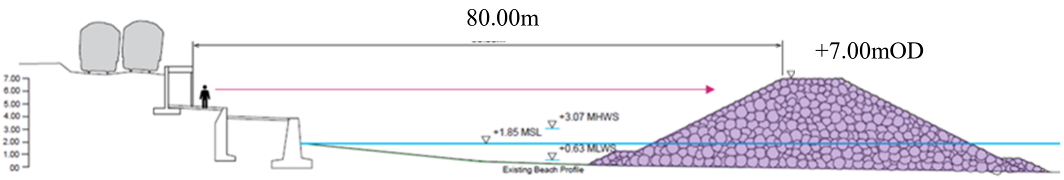


Figure 3 Schematic showing the visual impact of the breakwater solution

- Potential significant impacts on coastal processes. In particular, the presence of the breakwater will cause sediment deposition which could impact Dawlish Water flow.
- Buildability and risks of significant working over water on an exposed site.
- Would not provide resilience to the pedestrians on the promenade.
- Difficulty and costs in obtaining consents and impacts on programme duration. This includes the added cost/difficulty with lease/buying seabed from Crown Estates.
- H&S risks associated with people climbing on the breakwater and possible rip currents through the gaps in the breakwaters making it unsafe to swim in the area.
- Higher carbon impact in materials and construction activities than other options.
- Potential negative impacts on water quality. The presence of the breakwater could change the currents which naturally clean the area. The breakwater could create stagnant areas where the water does not circulate well. In addition, and as a consequence of change in the currents, debris could accumulate on the lee side of the breakwater requiring maritime plant for maintenance.

DOCUMENT CHECKING (not mandatory for File Note)

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