Punakaiki seawall impacts

Technical note for West Coast Regional Council

03 January 2007

Background

This technical note is part of a range of advice being provided to West Coast Regional Council (WCRC) to aid decision-making processes associated with ongoing erosion problems at a number of locations in the region. The purpose of this technical note is to provide advice on specific queries raised by WCRC's Consent Team associated with the retrospective resource consenting of the recently constructed Punakaikai seawall and any possible future extension and / or heightening of the wall. The assessment is based on a number of visits to Punakiaki over the last year since the construction of the wall.

This advice has been supported by the Foundation for Research, Science and Technology Envirolink fund set up to assist Regional Councils in accessing environmental advice from the various Crown Research Institutes.

The specific issued raised by the WCRC Consent Officers for comment on are related to:

- The potential for end effects of the existing and any extension of the seawall at the northern end.
- The appropriateness of the design of the wall.
- The effects of the seawall and any future extension on coastal dynamics.

Assessment of seawall impacts

<u>General Impacts</u>

The impacts of linear defences such as seawalls and revetments on surrounding beach systems are well documented although the specific processes causing these impacts less well understood. The ends of such defences, both updrift and downdrift, are often subject to local erosion problems, particularly where there is a strong net longshore transport of beach sediment, or where the line of the defence is not in alignment with the natural planshape of the coastline. Dean (1986) noted some other common impacts which include:

- Coastal armouring placed in an area of existing erosional stress can cause increased erosional stress on the beaches at either end of the armouring. By preventing continued erosion of a section of beach, the beaches adjacent to the armouring share a greater proportion of the same erosional stress.
- Coastal armouring placed in an area of erosional stress will cause the beaches fronting the armouring to diminish because the erosional demand is now limited to the fronting beach. Whilst the armouring may protect the land backing it, it does not

prevent erosion of the beach in front of the armouring. If the armouring had not been placed, the beach width would have remained approximately the same but would have migrated progressively landward.

- Isolated coastal armouring can accelerate downdrift erosion if long term retreat of the adjacent coastline results in the armouring protruding in to the active beach zone and interrupting longshore sediment transport.

Impacts of Punakaiki seawall

Over the last year an erosion scarp has occurred along the dune face at Punakaiki to the immediate north of the revetment (Figure 1). The beach in front of the structure also appears to be lower than that further north along the section backed by dunes.

Figure 1: Beach and dune changes at the northern end of the rock revetment at Punakaiki over the last year: Top left: November 2005, Top right: May 2006, Bottom left: November 2006, Bottom right: December 2006.

The lowering of the beach and scarping of the dune face at Punakaiki is likely to have been predominantly caused by the storm events that the west coast experienced over the 2006 winter. A number of these storm events (notably the storms on 06 May and 12 June) resulted in similar responses in other beach and dune systems on the West Coast. Under such conditions beach levels tend to be drawn down as sand is moved from the beach on to the nearshore bars, (Figure 2). Under more quiescent conditions this sand would tend to be moved back onshore, particularly by longer-period swell, but this process or re-building beach levels and frontal dunes typically takes a much longer time-period, (there is often a well defined winter-summer cycle in beach levels). The lowering of the beach levels during these storms results in the frontal dunes becoming more vulnerable to wave attack. However, dunes are essentially a natural store of sand to be released to the beach when required during more stormy conditions.

Hence the occurrence of beach lowering and dune erosion over the last winter is not all that unusual given the storm events experienced and similar to the patterns of storm erosion seen at many other beaches along this section of coast recently.

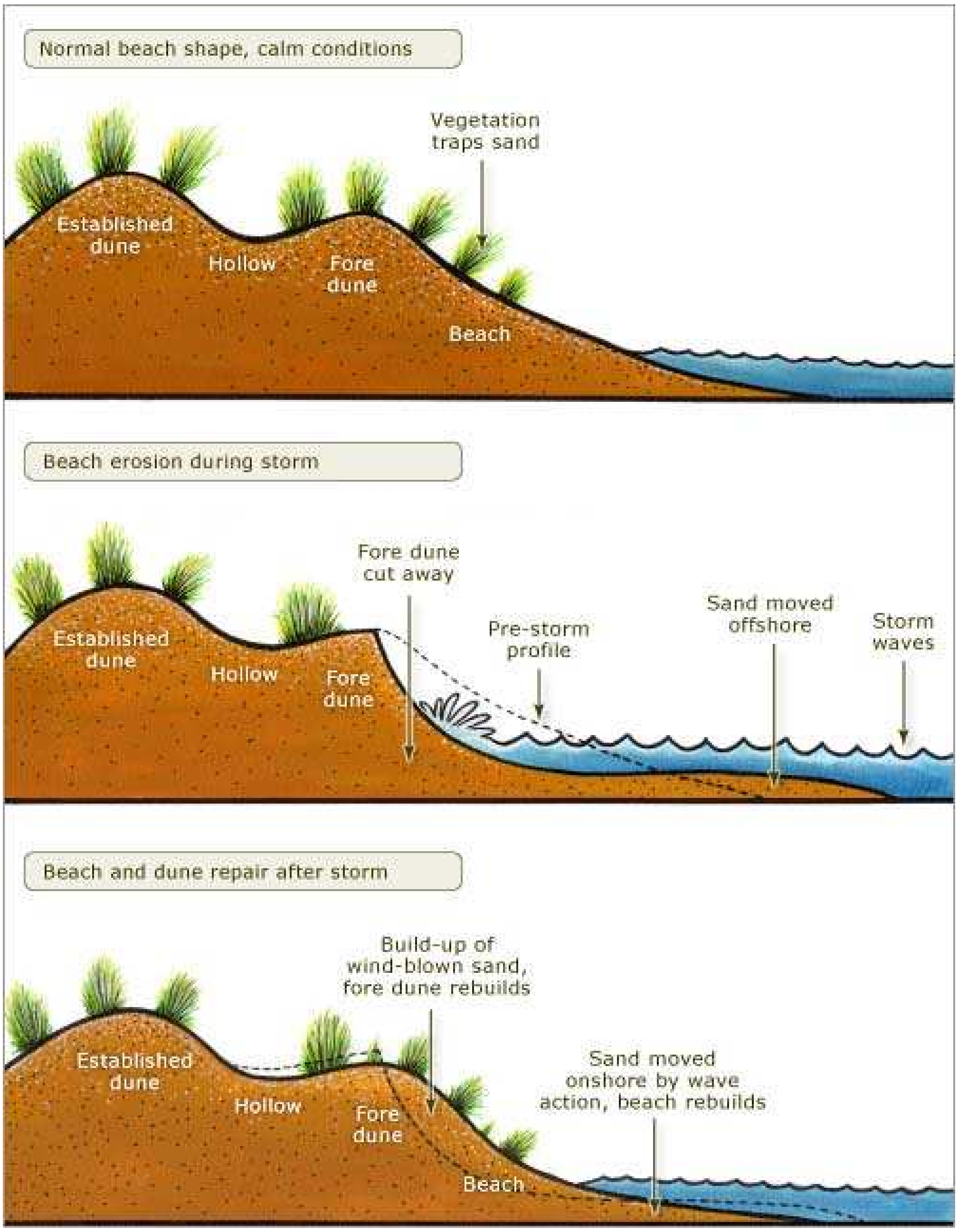

Figure 2: Typical beach and dune profile changes during storm events and subsequent recovery (Payne et al, 2003).

Whether the revetment has contributed to or exacerbated the magnitude of this beach lowering in front of the structure and / or dune erosion immediately to the north is difficult to ascertain at this present time (given the recent winter storm events). There is presently no visual evidence to suggest that the structure is having a significant impact on beach levels, with it noted between the visits in November and December 2006, of beach levels having recovered somewhat (also noted in other nearby beach locations e.g., Rapahoe). The lack of impact is in part due to the toe of the structure having been constructed around or above Mean High Water Spring (MHWS) tide level (the shallow slope and porous nature of the rock armour are also factors) but this could change in the future if landward movement of the entire beach system continues to occur resulting in the lower part of the structure being within the intertidal zone. This situation should be regularly monitored, particularly if the beach doesn't fully recover before winter.

End effects of the wall also do not appear to be significant at present, likely due to:

- The toe of the structure being generally above the intertidal zone resulting in little impact on longshore intertidal beach sediment movements (the magnitude of which is relatively low within this beach system).

- Limited wave reflection from the structure and no evidence of exacerbated beach lowering adjacent to the structure, which can allow larger waves to reach the dune toe adjacent to the structure.

At this stage, despite the storm induced erosion of the frontal dunes over the last year, there is still a well vegetated buffer of around 15-18 m wide between the beach and the seaward edge of the camp ground. As such there is nothing at urgent risk from erosion and little present justification for extending the revetment to the north. Indeed given that the beach becomes more exposed to the north to the dominant wave conditions to the south-west, and the likelihood that any coastal defence may well extend into the inter-tidal zone, potential impacts may well be greater than occurring at present if the wall is extended. It is suggested at this stage that if erosion management activities are required north of the existing revetment that there are likely to be more appropriate non-structural solutions. However, it may be necessary to conduct some future minor work at the northern end of the revetment. Although the revetment has been keyed in to the dune system to prevent outflanking, if landward movement of the beach system continues to occur, the risk of outflanking may well increase.

Appropriateness of the revetment design

In assessing the appropriateness of the design of the wall, we have only considered the specific design of the revetment, not whether some other form of erosion management was appropriate. The design, in terms of its engineering characteristics, is assessed under the following criteria and based on guidance provided by McConnell (1998) and CIRIA / CUR (1991):

- **Alignment of the wall:** The revetment generally follows the natural beach orientation and is unlikely to result in significant localised areas of scouring, beach lowering or overtopping.

- **Construction geometry:** The *slope* of the face of the revetment of between 1:2 to 1:3 is close to optimum for this type of structure and is a major factor in reducing the potential for wave reflection from the structure (and issue with steeper sloped or less permeable structures). The low slope also provides better run-up and overtopping performance than a steeper structure, and less potential for the armour layer to be damaged under storm wave conditions.

  With the *toe* of the structure positioned at, or above, MHWS level this reduces the present day impacts of the structure on the beach fronting it. Furthermore the toe of the structure appears to be adequately founded to cope with present day fluctuations in beach levels with no evidence so far of any significant risk of the revetment being damaged due to toe scour or falling beach levels.

  The width of the *crest* of the structure is around three rocks wide, which again is recommended design practice to ensure rock armour stability at the crest for such a structure. Whilst the height of the structure has not been designed based on any probabilistic assessment of wave and water levels and hence run-up and overtopping potential, the height of the structure appears to be sufficient to provide an adequate level of protection against wave run-up and overtopping, with the potential to raise the structure higher if an additional level of protection is required. However, the unprotected stopbank behind the revetment will be prone to erosion and scouring if waves do overtop the structure. If minor damage to the stopbank due to overtopping waves becomes more frequent then consideration may need to be given to either increasing the height of the structure (e.g., extra layer of rock, wave return wall etc) or increasing the level of protection over the stopbank.

- **End effects:** The potential for end effects have been reduced by a gradual change in the orientation of the revetment at the northern end of the beach, and the line of the revetment close to that of the natural beach.

- **Material:** The armour layer of two rocks thick is also recommended design practice for a structure located on the upper part of the beach on an open coast such as this. The rock armour in general has been well placed with minimal scope for armour movements. The sedimentary armour rock used is not ideal for coastal defence use being slaty and highly friable which may affect its long-term durability. However, it is appreciated that there is little available suitable rock armour on the West Coast. This is compensated somewhat by the size of the rock armour used which is probably larger than would be required if a full probabilistic assessment of armour stability was carried out during the design.

  The underlayer of geotextile to prevent foundation damage is also good practice.

Landscape Impacts (General Comments)

An assessment of the landscape impacts of the revetment is not provided here other than some general comments based on guidance provided by ECUS (2003). Again this does not assess how the structure compares, in terms of visual impact, with other potential solutions that may have been adopted:

- **Scale:** In general the size of the structure is not out of keeping with the scale of the coast and the landscape. Only from State Highway 6 (SH 6) at the southern end could it possibly be considered to have a more visually dominating impact on the beach landscape. The front face of the structure forms a similar slope to that found on gravel barriers on the upper part of many of the West Coast beaches, with the crest only marginally higher than the typical elevation of such barriers.

  The stopbank and revetment generally do not block sea views from the majority of the property behind the structure which tend to be on raised foundations. Nor does it obstruct views from SH 6.

  Given the backdrop of the limestone cliffs behind the coastal strip at Punakaikai, the revetment does not impact by towering above and dominating views from the foreshore.

- **Materials and colour:** The rock used is in keeping with rock types on the west coast and is similar in colour to the limestone cliffs backing the coastal strip at Punakaiki. However, the pale red-brown hues of the rock are less in keeping with the natural colours occurring on the foreshore.

- **Junction with other coastal elements:** The northern end of the revetment provides a relatively stark junction with the dunes beyond. The slope of the revetment eases the junction between the toe and the beach.

- **Access to the foreshore:** Access to the foreshore is generally over the revetment, with beach access limited at high tide in front of the structure.

Conclusions and recommendations

At present there is little evidence to suggest that the rock revetment in its present form is having any significant detrimental impact on beach processes or is responsible for any significant end effects and exacerbated dune erosion at the northern end of the structure.

There is potential for more significant impacts to occur if the structure is extended to the north but at this stage there appears to be no pressing requirement to do so.

The revetment structure has been well designed and generally conforms to best practice design guidance for such structures. Whilst there is a visual impact due to the structure, the scale and form of the structure would appear to be acceptable for such a structure.

It is suggested that a modest monitoring programme be commenced to monitor beach levels and dune position (Hume & Ramsay, 2005) involving:

- Establishment of two beach profiles, one just north of the northern end of the new rock revetment, and one mid-way along the spit.
- Establishment of at least one beach profile along the length of the revetment.
- Re-measurement of beach profiles on at least an annual basis but preferably 6-monthly in early spring and early autumn.
- Fixed aspect photography from all profiles at the time of beach profiling.

References

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