Coastal Adaptation Decision Pathways Project (CAP)

Assessment and Decision Frameworks for Seawall Structures

SYDNEY COASTAL COUNCILS GROUP

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The Sydney Coastal Council's *Assessment and Decision Frameworks for Seawall Structures* will assist Local and State Governments evaluate the robustness and condition of existing seawalls of unknown construction and quality; including identifying/ quantifying what exists, defining likely future changes to design conditions, and outlining possible options for further upgrades.

INTRODUCTION

This Assessment and Decision Framework for Existing Seawalls project will assist Local and State Governments' coastal managers to understand, from a practical perspective, the issues relating to small seawalls that are not certified.

The intent is to raise awareness of the potential issues arising from the existence of these structures and, where appropriate, to alert the coastal manager to potential signs of failure that might require detailed and expert professional assessment.

The guidelines in this report do not replace the need for that expert advice, but will assist the coastal manager to identify the issues and risks requiring professional assistance, and to ask the appropriate questions in the subsequent briefing process.

METHODS

The objective of the study is to identify information relating to the evaluation of the effectiveness of existing revetments constructed to protect properties where no design details are available.

This project has used literature searches and professional experience to identify the types of structures, likely failure modes, and shortcomings for adapting to future climate change.

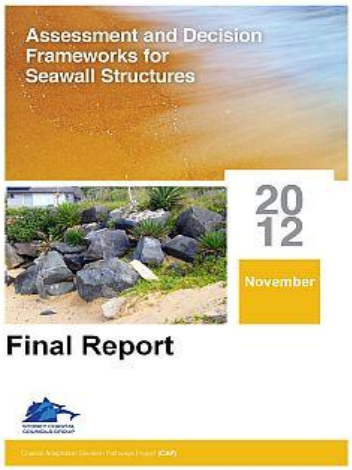
It has used field studies to assess methods for gathering additional data and the need for recording of information on these structures into a Council's asset management system.

Two case studies were used to investigate approaches to evaluating the condition and suitability of existing un-certified seawalls for current and future projected climate conditions.

KEY OUTPUTS

The key outputs of the study, included in the Final Report, are:

- Literature Review
- Geotechnical review of seawall and revetment stability
- Economic aspects of the appraisal of the effectiveness of seawalls
- Site field data collections
- Field assessment
  - Bilgola Beach
  - Clontarf Beach
  - Gold Coast A-Line



Geotechnical Review

The Geotechnical Aspects deals succinctly, in a clear style, with the key seawalls and modes of failure.

- Bulkhead Seawalls
- Rigid Gravity Seawalls
- Blockwork Gravity Walls
- Flexible Mass Gravity Seawalls and Sandbag Revetments
- Rigid Sloping Revetments
- Flexible Sloping Revetments

The report incorporates a pro-forma evaluation form for Local Government staff to undertake preliminary of seawalls and revetments for inclusion in Asset Management Systems.

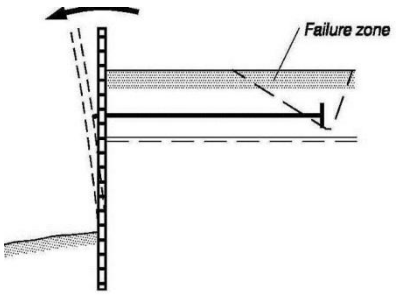


Figure 1 Anchored bulkhead wall – anchor pull-out failure mode

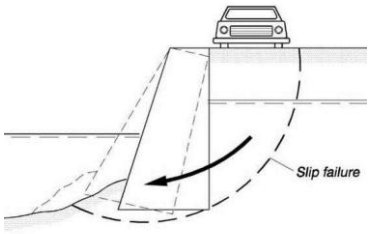


Figure 2 Rigid gravity wall – Rotational slip failure mode

Table 1 Typical Seawall Geotechnical Failure Modes

Failure Mode	Description
Overall / global stability	A slip failure that extends behind and below the wall
Bearing failure	Excessive settlement involving some rotation due to high foundation load or softening of the ground
Overturning failure	Rotation of the wall about its toe
Sliding at the base and or between wall elements	Excessive lateral movement of the wall away from the retained material
Toe erosion / scour	Removal of embedment material or seabed due to wave action
Internal erosion	Wash out of fine material causing cavities within the soil
Overtopping / overwash scour	Wash out of material behind the wall due to insufficient wall height against tide and wave action
Anchor or tie rod pull out	Insufficient anchor load to resist the lateral force applied on the wall

Economic aspects of the appraisal of the effectiveness of seawalls

The economic appraisal, based on a welfare economics approach, attempts to capture a full range of values to assist asset managers (and the community) make decisions about management of seawalls. We understand that economic appraisal (as applied in the case study) cannot answer these questions fully or appropriately. For the most part the seawall replacement questions will primarily be engineering and strategic planning or social questions, which economics cannot answer alone.

A spreadsheet, in Excel, provides a vehicle to gain insight into decisions about seawalls. The model is not exhaustive, or robust, to any/all situations and we do not intend to release it for general use.

The spreadsheet provides a cost-benefit framework, examining the costs and benefits associated with adaptation options in response to climate change projections, in locations where there is an existing coastal protection structure, and where this structure will not be suitable over the planning assessment period. It is not intended to be a standalone decision-making tool, and does not constitute professional advice, but is developed to demonstrate how different assumptions about key variables may influence the selection of appropriate adaptation options. In conjunction with the other components of this report, it can also suggest appropriate further investigations necessary to provide more certainty to the appraisal of these options in a formal context.

The spreadsheet allows both physical (environmental) factors, and soft factors (e.g. Management criteria) to be included.

Management Interventions

Broadly speaking, there are two classes of responses to the projected shoreline recession and storm impacts exceeding the design parameters of existing seawalls. The first class is the enhancement of the protective structures through either retrofitting or replacement, and the second is the removal of the assets currently protected by the seawall and the seawall itself. The enhancement of the protective structures could take two different forms, one being the use of hard structures such as the seawall, the other being the use of sand in the form of beach nourishment. Nourishment is a form of protection, or a means of delaying an inevitable retreat decision.

Sensitivity analysis shows that the favourability of each option is impacted differently by the variation in key parameters. Key among these is a parameter over which the manager has no control, the timing of storm impacts. The sensitivity analyses, though simple and based on a number of assumptions that require further testing, demonstrate that there is an obvious risk to effective management posed by the occurrence of a storm before a management decision has been made, or at a time that precludes strategic options such as efficient planned retreat.

It can also be shown that the high level of benefits assumed through protection of property drives the NPV of all options, favouring the retention of a seawall. This outcome takes no account of equity or social costs if the amenity of the beach is lost. Any planning decision needs to be taken in the context of overall social benefits and costs, and how those costs and benefits will be apportioned.

Site field data collection

The Bilgola Beach case study explored the use of an air lance, and ground penetrating radar (GPR) to assess the location and condition of existing seawalls that are below ground.

Both methods proved useful although the GPR, like any remote sensing technique requires experience to interpret the output with any confidence.

There is potential for other methods, such as ultraseismic, to be applicable for some kinds of masonry walls.

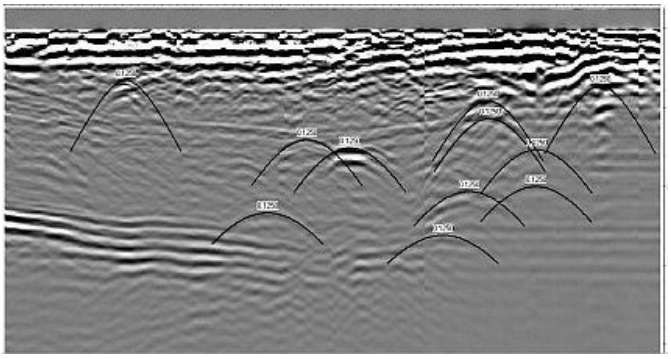


Figure 3 Ground penetrating radar image showing possible location of rocks buried in beach

Field assessment

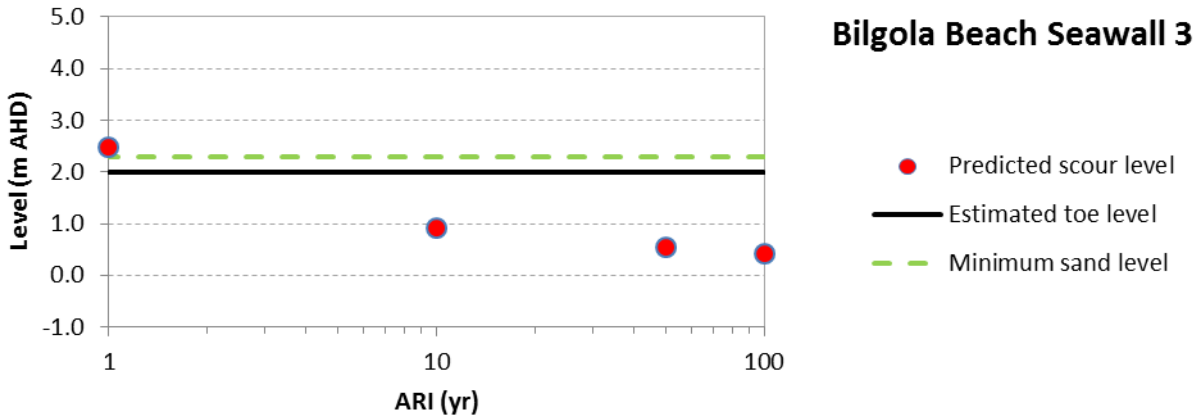
The assessments at Bilgola and Clontarf were purely a technical exercise in establishing and demonstrating methodologies for seawall assessment, and that while it considered the engineering, economic, wider environmental and community values, and planning contexts associated with managing seawalls, the level of detail or assessment and the assumptions required, are not suitable for planning or decision-making purposes at specific locations. The Report identifies this constraint clearly.

Bilgola Beach (exposed ocean beach, two revetment types)

The seawalls were assessed with regards to their suitability to withstand the occurrence of the adopted design storm event i.e. the 100 year ARI event for present day conditions and for the 2050 and 2100 planning horizons, including SLR projections. The following coastal processes were considered in assessing the likelihood of the seawall to fail:

- Erosion of sand in front of the seawall during storm events;
- Wave impacts due to elevated water levels and large wave conditions; and
- Wave overtopping of the seawall due to elevated water levels and storm wave conditions.

All existing seawalls were assessed from available historical data and by investigation. These data were compared to modelled data for beach scour to assess potential for failure. The example results below are for the seawall 3, in front of the Surf Club (south end of beach).



These results, if confirmed in more detailed investigations, would infer the need for additional toe protection to protect against increased toe scour with increasing sea level and wave energy. The study demonstrates the potential effectiveness of this approach to assessing, maintaining, and protecting coastal assets.

Similar studies for Clontarf adopted a similar approach to test methods for estuarine walls. The Gold Coast A-Line case study illuminates issues arising from the different strategies for the construction of Seawalls.

CONCLUSIONS

The existence of coastal protection structures without certification poses a particular difficulty for Local Government. Frequently, such structures are often not formally recognised and are not included within the Local Government asset management system.

The possibility exists that these structures may be ineffective, ultimately resulting in damage to assets they are supposed to protect. By their nature, seawalls resist the landward incursion of coastal processes during severe events. However, this may result in the transfer of storm impacts to adjacent land (seaward or further along the coast) with loss of public amenity and environment or, possibly, damage to adjacent property.

RECOMMENDATIONS

1. Councils review the protection structures currently existing along their foreshores
2. Councils identify all structures on public land and incorporate assessment and management of these structures into their current asset management systems
3. Councils review their asset management processes specifically in relation to protection structures of all types determining their future role and how they are proposed to be managed
4. For minor structures, Councils implement relevant and ongoing monitoring regimes to collate data and to gain a better understanding of their current performance and likely future performance in providing the requisite level of protection.
5. Where Council identifies liability issues arising from the location and/or condition of these structures, Council enter into discussions with local residents regarding these issues and potential outcomes. This should be undertaken within the framework of developing and implementing an overall coastal strategy for the beach compartment.

Australian Government
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