30 October 2017

WRL Ref: WRL2017065:DH:JTC LR20171030

Mr Tim Fitzroy
Byron Shire Council
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Water Research Laboratory

Dear Tim,

Clarkes Beach Access

1. Introduction

Recent erosion at Clarkes Beach has caused the seaward end of the concrete beach access path to collapse (Figure 1, Figure 2). The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering, UNSW Sydney has been commissioned by Byron Shire Council (Council) to investigate options for reinstating beach access.

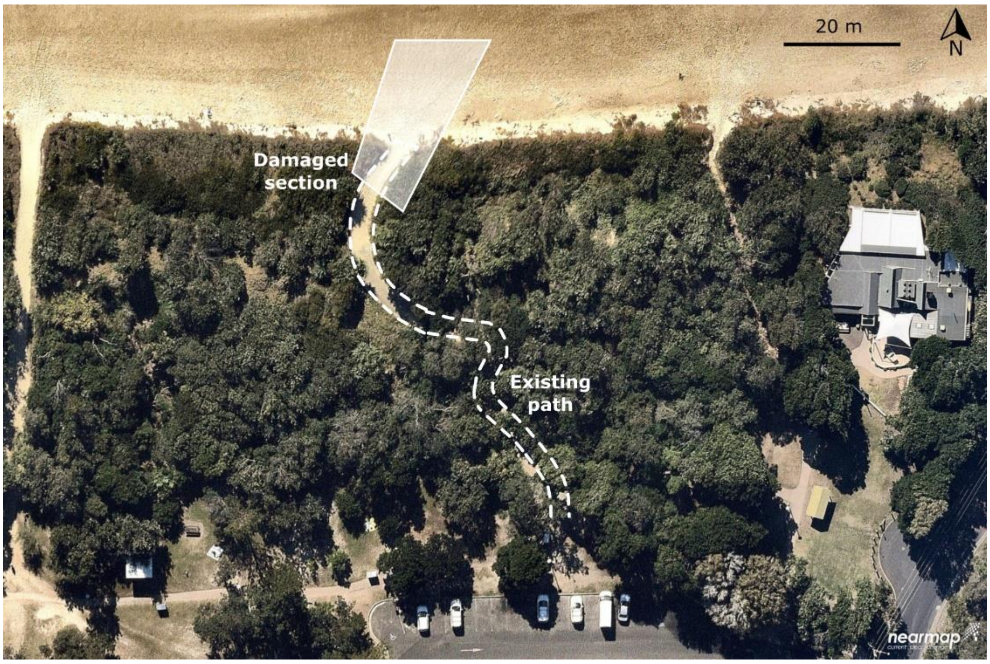

Figure 1. Access path to Clarkes Beach (source: Nearmap/BSC)

Figure 2. Damaged section of access path (source: BSC)

2. Practical considerations

2.1 Materials

WRL considered a range of options for providing beach access, using a range of materials including timber, recycled plastic, glass-reinforced plastic (GRP), and reinforced concrete. Metal/steel walkways were initially considered, but were excluded because they are not widely used for beach access in Australia, and they were not deemed to be consistent with the character of the site.

2.2 Slope

WRL understands that Council would prefer a ramp instead of stairs, however, as stated below, a ramp (or ramps) in full compliance with disability access standards would best be located in other locations within the Byron Bay embayment.

For wheelchair access, Australian Standard 1428 *Design for access and mobility* requires that ramps have a maximum slope of 1V:14H, with flat landings (1200 mm long) provided every 9 m, giving an overall slope of approximately 1V:16H for long ramps. Due to the space required for this form of access, beach access compliant with this standard would best be located in the vicinity of the Pass or the Jonson Street seawall.

If full wheelchair access is not required, a steeper ramp can be used. AS 1657 *Fixed platforms, walkways, stairways and ladders—Design, construction and installation* allows a maximum slope of 1V:8H. Ramp gradients steeper than this can still comply with this standard through the use of cleats on the ramp surface.

The AUS SPEC *Geometric Road Design* manual recommends a maximum road gradient of 16% (1V:6.25H).

AS 2890 *Parking facilities: off-street car parking* recommends a maximum slope of 1V:4H.

The Department of Land and Water Conservation *Coastal Dune Management* (2001) manual recommends that paths match the slope of the dune, and that steps are to be provided if the slope exceeds 1V:4H.

2.3 Coastal hazards

The beach access path will be subjected to coastal processes/hazards. These hazards were quantified in BMT WBM (2013) as follows:

- Ongoing recession: 0.2 m per year;
- Beach erosion:
  - "design" 100 year ARI: 150 m^3/m from BMT WBM (2013)
  - 10 year ARI year ARI: 75 m^3/m calculated by WRL based on Gordon (1987);
- Wave runup during storms (nominally 100 year ARI): 4.3 m AHD.

Sea level rise was considered in the BMT WBM (2013) hazard study and WRL (2016) management options study. For the planning period of 10 to 20 years the subject beach access, sea level rise is likely to be minor.

Depending on the final design of the beach access path, it may be exposed to waves and/or dune reshaping from storm events. This section of Clarkes Beach is active, and the historical photogrammetry beach profiles show large variation in the past 70 years (Figure 3). The access path is within the 100 year ARI erosion hazard line (Figure 4). Erosion hazard lines for this study are based on the "zone of slope adjustment" calculated using the Nielsen (1992) method, on the 1999 surveyed beach profile, with erosion volumes based on guidance from Gordon (1987).

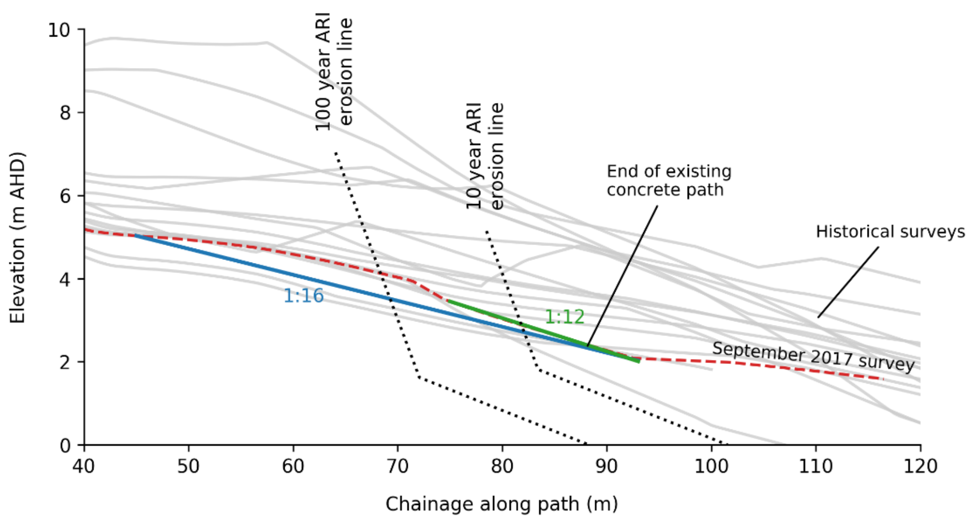

Figure 3. Elevation profile of existing path and historical beach surveys

Figure 4. Approximate storm erosion hazard lines (image: Nearmap)

3. Options

3.1 Flexible structures

3.1.1 Timber board and chain

Timber board and chain paths are ubiquitous on Australian beaches (Figure 5), and can use narrow boards with a wide spacing or wide boards with a narrow spacing.

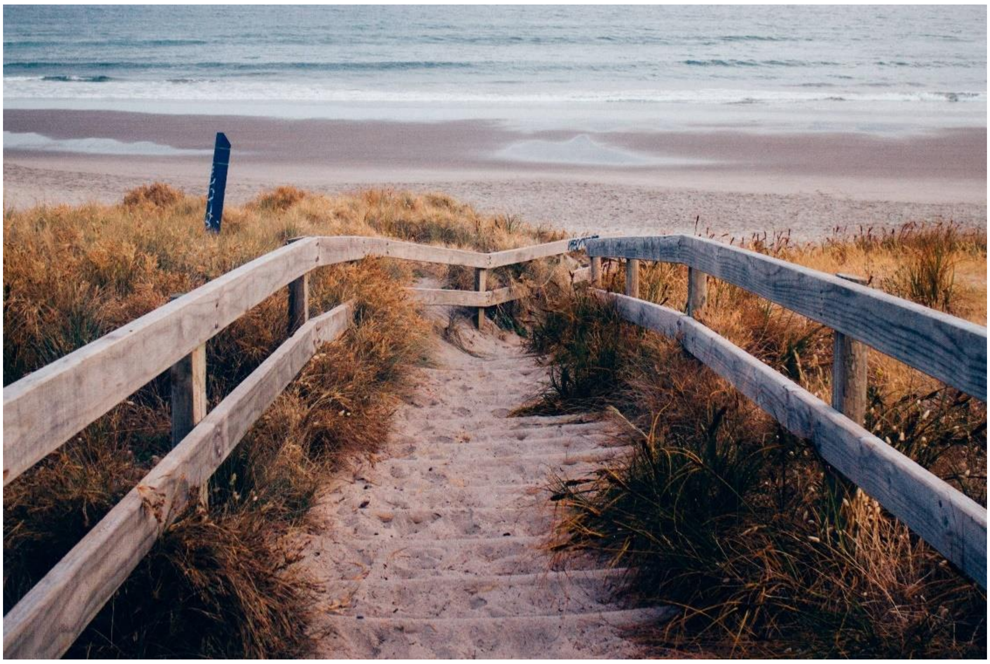

Figure 5. Board and chain path (source: T Marshall, unsplash.com)

Advantages:

- Simple to construct and repair;
- Low impact on beach; and
- Can accommodate dune reshaping without structural failure.

Disadvantages:

- Must be manually re-established after major erosion to dunes (Figure 6);
- Corrosion of galvanised bolts and chains (stainless steel fittings could be used but these may then substantially exceed the life of the timber);
- Decay of timbers;
- Potential for splinters; and
- Can be difficult to negotiate if timbers are too narrow and too widely spaced.

Figure 6. Destabilisation of board and chain path after dune erosion (source: J Carley, WRL)

3.2 Semi-rigid structures

3.2.1 Modular plastic path

Modular paths made from recycled plastic have been used as access ramps at a number of beaches in NSW (Figure 7). The main supplier of these produces in Australia is Replas (www.replas.com.au).

Figure 7. Modular plastic ramp at Pambula Beach (source: Replas)

Advantages:

- Simple to construct;
- Surface provides good grip;
- Splinter free;
- Corrosion free and decay free; and
- Modules can be temporarily removed to prevent damage during storms.

Disadvantages:

- Potential slip hazard with dry sand at steep gradients;
- Long term performance untested;
- Potential for plastic waste from damage and degradation; and
- Modules can be easily washed away if left in place during storms.

3.3 Lightly engineered structures

3.3.1 Timber boardwalk

Timber boardwalks (with stairs) are commonly used for accessing beaches backed by cliffs or near headlands. The design life of these structures varies, depending on the depth of the foundations. Timber uprights can withstand moderate wave forces and some debris impact, but the deck boards may fail if exposed to uplift forces from waves. Deck stability can be improved by using screwed and bolted connections, rather than nails.

Figure 8. Timber boardwalk (source: A Sharov, unsplash.com)

Advantages:

- Easy to construct and repair;
- Can be elevated to allow vegetation growth and fauna passage under;
- Resistant to corrosion;
- Materials are mostly renewable;
- High aesthetic appeal (compared with other construction materials); and
- Comfortable for bare feet.

Disadvantages:

- Requires detailed structural design;
- Cannot withstand large wave forces;
- Has potential for splinters;
- Mould can develop, creating a slippery surface, particularly if softwood timbers are used;
- Timber needs to be either native hardwood or chemically treated softwood; and
- Timber requires more maintenance than other construction materials.

3.3.2 GRP (Glass Reinforced Plastic) boardwalk

GRP boardwalks have been adopted at some beaches in NSW as a low-maintenance alternative to timber structures (Figure 9).

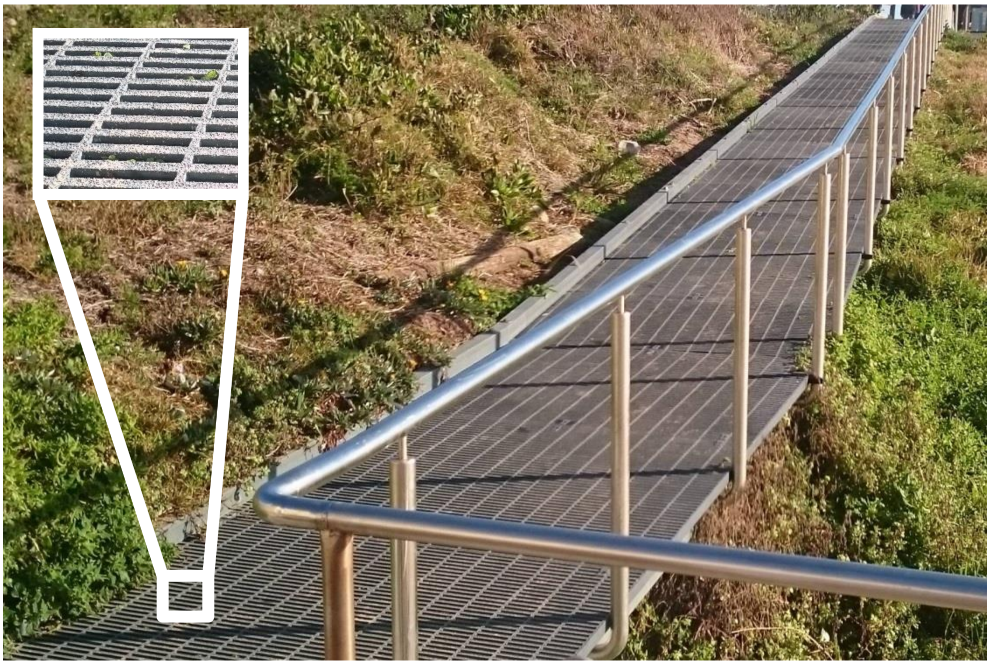

Figure 9. GRP boardwalk at Curl Curl

Advantages:

- Surface provides good grip;
- Moderate resistance to wave forces if well founded;
- Can be constructed with traditional carpentry tools (except for balustrades);
- Resistant to corrosion and decay;
- Can be elevated to allow vegetation growth and fauna passage under; and
- Low maintenance requirements.

Disadvantages:

- Requires detailed structural design;
- Surface can be unpleasant for bare feet; and
- Long-term performance is unknown.

3.4 Comprehensively engineered structures

3.4.1 Reinforced concrete ramp

Reinforced concrete ramps are typically used in high-traffic areas on urban beaches. They can be built to withstand storms, but are expensive and often have a strong visual impact (Figure 10).

Figure 10. Reinforced concrete ramp at Curl Curl

To fully withstand coastal processes, these structures need to be founded on piled footings, which are appropriately designed as friction piles, or founded on bedrock. A structure such as this is not well suited to the subject location due to the high degree beach change there. Such a structure would be best suited to either the Pass or the Jonson Street seawall due to the presence of more stable beaches/structures/natural features at those locations.

Advantages:

- Surface provides good grip;
- Low maintenance requirements; and
- Generally able to resist wave attack and debris loads during storms.

Disadvantages:

- Requires detailed structural design and formwork;
- Inflexible and difficult to modify;
- Expensive.

4. Comparison of options

The options described above are compared in Table 1.

Table 1. Comparison of beach access options

Option	Indicative capital cost	Design life (years)	Design storm ARI (years)	Maintenance requirements	Has precedent in NSW	Impact on beach processes	Discomfort for bare feet	Slipperiness	Potential low mobility access
Board and chain		10	5	high(1)	✓	low	mod.	mod.	(2)
Modular plastic path			5(3)	mod.(3)	✓	low	mod.	low	✓
Timber boardwalk		20	10	mod.	✓	low	low	mod.(4)	✓
GRP ramp		20	20	low	✓	low	mod	low	✓
Reinforced concrete		50	100	low	✓	mod.	low	low	✓

Notes:
1. Board and chain must be adjusted after major changes in dune shape.
2. Access is possible if boards are wide and closely spaced.
3. Modules can be temporarily removed to prevent damage during storms.
4. Softwood is susceptible to mould growth, and can become slippery with time.

5. Guidance on selection of preferred option

The remaining portion of the existing beach access consists of a concrete slab on ground. The erosion hazard assessment indicates that larger erosion events than recently experienced are possible and therefore part of the remaining path could be vulnerable to further undermining. It may be acceptable to leave this vulnerable remaining portion intact provided that if undermined, it does not cause the collapse of newer seaward portions.

With the concurrence of Council, the following suggestions are made:

- Landward of the 100 year ARI erosion zone:
  - Any option can be pursued, noting that elevated structures can allow vegetation growth and fauna passage;

- Between the 100 year ARI and 10 year ARI erosion zone:
  - A rigid option founded on piles will allow the continuation of a planar ramp with only occasional interaction with coastal processes. Such piles will need to be founded on bedrock or designed with sufficient foundation friction.

- Seaward of the 10 year ARI erosion zone:
  - A board and chain structure with a maximum gradient of 1V:4H is recommended.
  - Minor local beach scraping and adjustments to the boards will be needed to retain beach access following storm erosion events.

6. Chosen option

A revision of this letter will be provided upon consideration of the above by Council.

7. Summary

Thank you for the opportunity to provide this advice. Please contact James Carley or Dan Howe should you wish to discuss this matter further.

Yours sincerely,

Grantley Smith
Manager