SUBMERGED GROYNES FOR BEACH STABILISATION

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INTRODUCTION
Typically, rubble mound groynes are constructed by end tipping from trucks for which the roadway level must be above high tide. Some adverse effects of such surface-piercing groynes include the generation of rips along their trunks (Fleming 1990; Scott et al., 2016), which can transport sand off the beach and out of the groyne compartment. Further, rubble mound groynes have large footprints that may smother benthic habitat.

A submerged groyne may obviate such potential adverse impacts. Submerged groynes are used in England to stabilise shingle beaches (Simm et al., 1996). The groyne extends offshore but underwater, protruding far enough above the seabed to arrest alongshore transport of littoral drift. However, scale modelling (Jensen 1997) showed that groynes remaining below the water surface allow for the expansion of rip currents and, hence, a reduction in their velocity and their capacity to transport littoral drift offshore and beyond the groyne compartment. Further, submerged groynes can comprise sheet piling, which may be timber (as used in UK), fibre-reinforced plastic, steel or concrete, which present a negligible footprint, having a minimal impact on benthic habitat.

Erosion at the somewhat sheltered Foreshore Road Beach, Botany Bay, followed its restoration as part of the Port Authority of NSW Port Botany expansion project (Figure 1), which also caused nuisance flooding in Botany from blocked stormwater drains (Figure 2).

This paper presents the design, the results of a mobile bed scale model study and the first practical application in Australia of a submerged groyne field solution for beach stabilisation.

GROYNE FIELD DESIGN
Recommended works (Figures 3 and 4) comprised two short rock armoured groynes enclosing the storm water pipes and extending into Botany Bay along with much longer submerged fiber-reinforced plastic sheet wall extensions. An additional plastic sheet pile groyne was included between the pipes to stabilise the beach further. Alongshore pedestrian access was provided at the root of each groyne. Visually, the groyne extensions were unobtrusive (Figure 5).

MOBILE BED SCALE MODELLING STUDY
Following the method of Nielsen et al. (2000), a novel mobile bed physical scale modelling study was undertaken at the NSW Public Works Manly Hydraulics Laboratory to determine the beach shapes that would
develop between the novel groyne structures. Model testing was undertaken in a 30 m×18 m×1 m wave basin at a natural scale of 1:80. The model sediment comprised plastic beads (S.G. = 1.37; D50 = 3.0 mm), chosen to be mobilised readily under the wave heights to be used in the model, creating a berm representative of a sandy beach berm under changing water levels. The model was run using bi-modal spectra of swell waves refracted into the bay and local seas.

The mobile bed scale modelling enabled the determination of future alignments for an eroded beach (Figure 6 left) and a beach stabilised with submerged groynes (Figure 6 right). The former confirmed model validation and the latter allowed for the determination of the required volumes of beach sand nourishment. The final alignments of the beach compartments as predicted in the model are shown in Figure 7.

![Figure 6 - Mobile bed model of the eroded beach (left) and the beach stabilised with groynes (right)](image)

![Figure 7 - Alignments of the beach compartments predicted by the mobile bed model](image)

**CONCLUSIONS**

A novel fibre-reinforced plastic sheet piling submerged groyne field has been used to stabilise Foreshore Road Beach on the northern shores of Botany Bay.

Beneficial features of the structures include:

- On high tides and during storm surge conditions the groynes are submerged, which obviates the formation of the rip currents that would take sand offshore from the beach during severe storms
- The minimal footprint of the structures obviates any significant impact on benthic habitat including the existing offshore seagrass meadows
- Ease of installation
- Non-corrosive properties
- Visual unobtrusiveness.

Small-scale basin modelling utilising plastic mobile bed sediments proved to be successful in predicting medium-term wave-generated plan-form beach response and, hence, nourishment requirements.

To the authors' knowledge, this is the first installation of such groynes in Australia.

**REFERENCES**

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