Category:
Technical Note

Title:
Special construction requirements for artificial surfing reefs

Running Head:
Surfing reef construction

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ABSTRACT

Construction of artificial surfing reefs requires methods and materials that are different from those used traditionally for conventional breakwaters. In particular, the need to address safety and increased volume requires materials to be user-friendly and economical. This requirement has led to furthering the development of technology to manufacture and place large, sand-filled geotextile containers for projects such as Narrowneck Reef on Australia's Gold Coast.

Additional Index Words: geotextile, safety, coastal protection, amenity, waves.

INTRODUCTION

The increasing worldwide interest in reefs for surfing (or shore protection and surfing) has led to considerable research into what makes the perfect wave (Mead and Black, this issue) and the development of modelling to design the best reef shape for the particular location (Black *et al.*, this issue). Where the reef must also act as an effective submerged or emerged breakwater for shore protection, as well as achieving high quality and consistent surfing conditions, the design complexity is compounded.

Conventional breakwaters have been generally constructed to be cost-effective, stable and durable for the design conditions. Rock and/or concrete armour units are the most common construction materials and, where possible, use of such structures has been discouraged. With conventional breakwaters there is generally no need for highly accurate surface levels and a rough permeable surface layer is usually desirable to efficiently dissipate wave energy. However, to achieve the design potential, reefs for good consistent rideable surfing waves need to be constructed to achieve the design shape within much tighter tolerances than conventional breakwaters. Also, as safety is of paramount importance, the materials used need to be as surfer friendly as possible and placed so as to minimise risks to surfers from potential snags to legropes, voids and other hazards. These special requirements have led to the need to develop different construction materials and techniques on surfing reef projects such as the multi-purpose reef at Narrowneck on the Gold Coast.

SPECIFIC REQUIREMENTS

In nature, rough boulders or reef discontinuity often lessen the quality of many good breaks. To ensure that waves peel progressively, sudden changes in bathymetry need to be avoided. Therefore, surfing reefs need to be constructed with a relatively smooth surface. Also, the slopes need to be relatively flat to achieve the desired wave shoaling, refraction and peel characteristics and to avoid slumping or surging of the wave face.

The safety issue is of paramount importance. Many existing man-made breakwaters and groynes provide good surfing conditions in the right combination of conditions, but the roughness and shape are often dangerous.

The construction of surfing reefs can be compared with the construction of ski slopes, skateboard bowls etc. Legal advice is conflicting but generally if all reasonable efforts are made so that the reef is constructed to minimise danger, then the risk of litigation is minimised.

Durability is important and the effects of surf craft and their fins need to be allowed for in the selection of materials. However, durability is considered secondary to safety. As with other recreational facilities, some maintenance should be expected

Cost is a critical factor to the viability of any facility, but the benefits of surfing reefs is being found to be high.

CASE STUDY - THE NARROWNECK REEF, GOLD COAST

Background

The Gold Coast beaches and surf are vital to the local tourist economy. To mitigate the effects of storm erosion events and long term sea level rise, the Northern Gold Coast Beach Protection Strategy was prepared for Gold Coast City Council (ICM, 1997). As surfing is a popular Gold Coast recreational activity, which supports related manufacturing and retail industries, it was recognised that any works should not impact negatively on the surfing community.

In brief, the adopted strategy is: -

- to nourish and maintain the beaches (1.1 million m^3 initially plus 80,000m^3yr^{-1}) in an integrated scheme with the Dept of Transport using sand from navigation channels in the Broadwater

- construction of a submerged reef at Narrowneck just downdrift of Surfers Paradise to stabilise the nourished beaches and provide a reef break for surfing

The concept of a reef designed as an artificial surfing reef gained considerable support from a wide sector of the community and is the ongoing main aspect of public and media interest.

Design

The final approval stage required a number of comprehensive impact assessment studies and detailed design of the reef. The detailed reef shape and location was carried out by Black *et al*. (this issue) to optimise the beach stabilisation and surfing aspects. 300 model runs using wave and sediment transport, calibrated with data collected from natural surf breaks around the world, resulted in a novel reef shape. The final reef shape consists of two parts, northern and southern. The northern part will form a right hand break, while the southern side will form one of the very few left-hand breaks on the Gold Coast. The shape of the reef will also enhance the wave height by about 25%. The numerical modelling was checked with a physical model by Turner *et al*. (this issue), which showed that the mathematical design was effective and construction was then commenced.

Construction Method

An innovative construction methodology using very large prefabricated geotextile containers filled from offshore in a dredge hopper was developed for the project. This method has the following benefits:

- ~50% cost of rock
- able to achieve design shape
- surface reduces risk of injury to surfers
- no works on beach or impact on beach users
- no rock haulage and impacts on roads or users
- flexible to cope with seabed movements

- able to be easily topped up, modified or removed if necessary, the latter being important for the approvals.

To achieve best accuracy for the design shape, 3 different sizes and shapes of sandbags ranging from 20m long x 3m diameter (~150 tonnes) to 20m long x 4.6m diameter (~450 tonnes) are being used. Also, the bags are being monitored accurately after placement and the bag layout modified as construction progresses. A shallow-draft split-hull hopper dredge is being used to place the bags using satellite position fixing.

The bags are being manufactured from non-woven geotextile and the construction method consists of unrolling a prefabricated geotextile bag into the dredge hopper and filling the bag with sand with the dredge (Figure 1). When filled, the bag inlets and outlets are sealed and the dredge positions itself, opens the hopper and drops the bag (Figure 2).

Cost

The Narrowneck reef (Figure 3) is part of the Northern Gold Coast Beach protection strategy which has an overall benefit cost ratio of approx. 70:1 without consideration of the surfing aspects. The surfing aspects are significant as the reef is estimated to have a economic benefit of $A2.2 million each time a major international surfing contest is held on the reef. With the expected good consistent surfing conditions predicted, several such contests per year are expected. The present design uses over 300 sandbags to construct the reef. The expected final cost is $A2.5 million.

CONCLUSIONS

The design of artificial surfing reefs requires appropriate methods and materials. Conventional methods, used traditionally for breakwaters, will not be suitable in many cases. In particular, with the need to address safety to users and the increased volume required, materials must be user-friendly and economical. This has led to developments in the technology required to manufacture and place large, sand-filled geotextile containers.

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REFERENCES

ICM (1997) “Northern Gold Coast Beach Protection Strategy – Report on Recommended Strategy”

Figures

Figure 1. Prefabricated geotextile bags are unrolled into the dredge hopper and the bag is filled with sand by the dredge

Figure 2. Once filled, the bag inlets and outlets are sealed and the dredge positions itself (using DGPS), opens the hopper and drops the bag in place.

Figure 3. Narrowneck Reef on the Gold Coast during small wave conditions.

SPLIT HULL HOPPER DREDGE FILLING SANDBAG

Figure 1. Prefabricated geotextile bags are unrolled into the dredge hopper and the bag is filled with sand by the dredge.

SPLIT HULL HOPPER DREDGE PLACING SANDBAGS

Figure 2. Once filled, the bag inlets and outlets are sealed and the dredge positions itself (using GPS), opens the hopper and drops the bag in place.

Figure 3. Narrowneck Reef on the Gold Coast during small wave conditions.