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A major failure involving an exposed geotextile to contain dredged spoil

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ABSTRACT

The development of facility for the export of LNG from coal seam gas required a major dredging program which, due to the proximity of the Great Barrier Reef, was subject to strict environmental conditions. Most of the dredged spoil was required to be disposed of into a purpose-built bunded disposal area, constructed over existing seabed shallows. The as constructed rock fill embankment unintentionally allowed significant leakage of dredged spoil through and along much of its perimeter, compromising the disposal area's effectiveness in meeting water quality requirements. The loss of the dredged material through the embankment was primarily attributed to the geotextile component of the wall not performing as anticipated by the design and construct alliance. The design and construction factors that lead to the failure are discussed. Guidance is provided so as to avoid similar designs from being implemented in the future.

1. Introduction

Gladstone Harbour Queensland Australia is a major coal export port. In the mid-2000s it was nominated as the port for the export of Liquid Natural Gas (LNG), extracted from coal seams and transported over 400 km to Gladstone via pipelines. Four major gas export terminals were planned, with one completed and two currently nearing completion. Investment in these projects will exceed AUD 60 billion (about USD 55 billion). A major dredging program (of over 20 million cubic metres) was necessary to provide navigation channels and turning basins for the ships and associated equipment involved in the export of the gas. Due to the proximity of the harbour to the Great Barrier Reef, strict environmental conditions were imposed, by both the Federal and State governments on the dredging activities, including the disposal of the dredged material. Most of the dredged spoil was required to be disposed of into a purpose-built bunded disposal area, constructed over existing seabed shallows. The disposal area was required to be sealed to prevent loss of dredged spoil, with all discharge of dredged tailwaters being filtered then directed through one outlet into the harbour. A geotextile formed an important component of the bund design. The quality of the discharge from the one outlet was required to be monitored to meet strict water quality standards.

The marine and coastal environment is an extremely harsh environment to use a geotextile, as it will be subjected to impact and abrasion from armour rock and marine sediment, large dynamic flow conditions from both tidal action and wave impact. As such, geotextiles used in coastal and marine projects must be able to withstand conditions which are far more aggressive than typical road construction applications. Any design incorporating geotextiles in the coastal environment must allow for not only the harsh in service conditions but also the dynamic and potentially difficult construction conditions. Experience with silt curtains in coastal applications has shown that wave conditions, geotextile filter characteristics and anchoring systems require sound design practices to give them a chance to perform the task required, this project has many parallels with silt curtain design.

Coastal revetments have been built to provide protection to the coastline for hundreds of years and geotextiles have been successfully incorporated into these structures for approximately 50 years. In Australia, a standardised approach to the selection of geotextiles for various applications in road construction was

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adopted by the New South Wales and Queensland road authorities in 1997, however there is no such tool for coastal and marine structures. Designers must therefore rely on international best practice, field trials or past experience to ascertain the suitable grade to be installed (Hornsey, 2012). While past experience is a good guide, the specifics of the project should be considered and a simple “cut and paste” design is not recommended.

In this the project to be described herein, the critical factor in the design was that the intention was to build a bund wall i.e. a structure to contain the dredged spoil, however the final product was a porous rock fill embankment. As a result, there was significant leakage of very fine grained dredged spoil along much of its perimeter, thereby compromising the disposal area's effectiveness in meeting water quality requirements. The loss of the dredged material through the embankment can be primarily attributed to the fact that the geotextile was not confined after placement and was therefore unable to perform as anticipated by the design and construct alliance. Figs. 1 and 2 show the dramatic outcome of a failure of the structure to achieve the design objective (i.e. retention of the dredged spoil). This paper investigates the factors which contributed to the failure and the lack of understanding of geotextile design and installation fundamentals which lead to poor performance of the structure.

2. Design

In revetment applications such as the Gladstone bund wall, the primary function of the geotextile is filtration (i.e., prevention of fine material washing through the coarse armour layer). Filter design should take into account the characteristics of the material to be retained and the expected flow conditions. In coastal revetment applications where tidal fluctuations and wave action are expected, dynamic (two way) flow conditions must be considered. Once the filtration design has been completed the survivability aspects must also be considered. This should include installation forces such as size and drop height of cover material, as well as longer term factors such as abrasion and UV resistance during and post construction forces.

2.1. Gladstone bund design

The Gladstone bund wall was intended to create a perimeter wall to contain dredged spoil generated during the development of ship access for the new LNG facilities built on Curtis Island. The dredged material contained a significant portion of very fine marine sediments with between 26 and 75% passing the 0.075 mm sieve (Fig. 3), with these also containing acid sulphate soils. This grading was obtained from samples from boreholes in the areas to be dredged. Due to the proximity of the site to the Great Barrier Reef Marine Park, strict guidelines were set in place to limit this material from entering the environment. In order to limit contamination, rock free of fines was used to build the bund wall.

Essentially there were two designs for the bund wall design. One, used for tendering purposes and shown in Fig. 4, was a standard design with the geotextile encapsulated within the structure. During the tender process the author contacted the designer to discuss the suitability of the geotextile specified (GTX 2) and subsequent to a meeting an addendum to the specification was

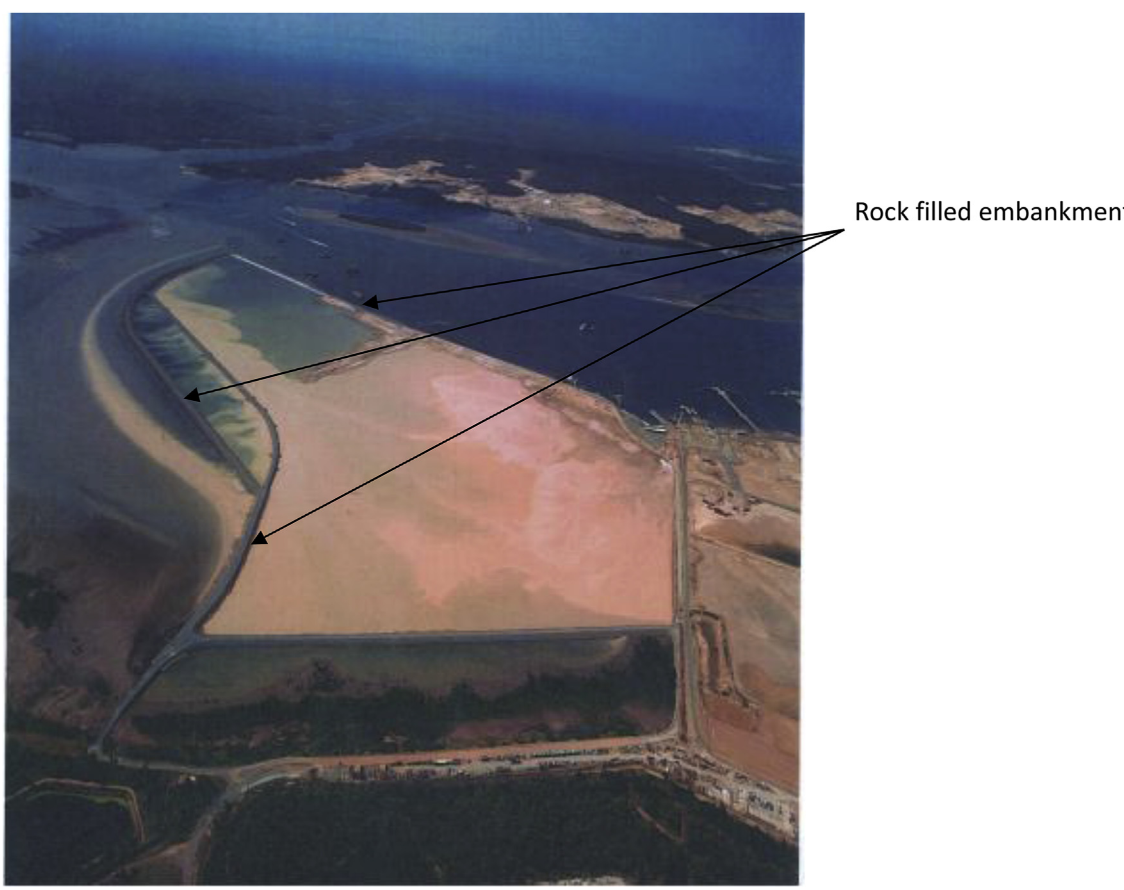

Fig. 1. Clear tracking of sediment through the rock filled embankment.

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