COASTAL DEFENCE: A NCE OF LABUAN

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ABSTRACT

Coastal defense structure is a structure used as deterrent or breakwater to mitigate erosion that occurred in coastal areas. However, failures often occur on the structure due to problems such as poor installation which does not follow the specifications. Another problem that normally caused the failure of coastal defence structure is the weak bed protection. As such, a case study has been conducted at Pantai Punggur, Johore that uses Labuan Block as coastal defense structure. The Labuan blocks constitute of two concrete block type that are Type B in trapezium shaped and Type A in square shaped. They are suitable to be used in the sandy beach area as wave deterrent. It used geotextile as bed layer. This study aimed to evaluate the effectiveness of Labuan Block at the stated area and factors that resulted in failure for the structure. Two methodologies were applied in this study, first by analyzing the hydrodynamic data such as wave, tide and soil profile to relate with the problem occurred. The second method is by doing visual inspection to get the actual view of the level of erosion and its effect on the study area. From the study, it was found that block height arrangement was not enough to withstand the wave especially during high tide. As a conclusion, suitable height arrangement and improvement on existing bed protection is suggested so that the implementation of Labuan block is more effective and able to last longer.

ABSTRAK

Struktur perlindungan pantai adalah binaan yang digunakan sebagai penghalang atau pemecah ombak di kawasan pantai bagi mengurangkan hakisan yang berlaku di kawasan pantai. Tetapi seringkali berlaku kegagalan pada struktur tersebut yang berpunca daripada beberapa masalah seperti cara pemasangan yang tidak mengikut spesifikasi yang betul dan juga perlindungan pada dasar struktur yang agak lemah. Oleh itu satu kajian kes telah dijalankan di kawasan Pantai Punggur, Johor yang menggunakan Labuan Blok sebagai struktur perlindungan pantai. Blok Labuan terdiri daripada dua jenis blok konkrit iaitu jenis B yang berbentuk trapezium dan jenis A yang berbentuk segiempat. Ianya sesuai digunakan di kawasan pantai berpasir sebagai penghalang ombak dan menggunakan geotektil sebagai pelapik pada dasarnya. Kajian ini bertujuan untuk mengetahui sejauhmana keberkesanan perlindungan dasar yang digunakan serta faktor-faktor yang menyebabkan kegagalan pada struktur tersebut. Dua jenis sumber maklumat digunakan dalam kajian ini iaitu pertamanya dengan menggunakan data hidrodinamik pantai untuk mengaitkannya dengan masalah yang berlaku. Sumber kedua adalah dengan melakukan lawatan tapak bagi melihat kesan-kesan kegagalan yang berlaku bagi mengaitkannya dengan kajian dari sumber pertama. Daripada hasil kajian didapati susunan ketinggian blok tidak mencukupi untuk menghalang ombak terutamanya ketika air pasang. Selain itu, geotekstil yang diganakan juga tidak berkesan sebagai perlindungan dasar yang efektif. Sebagai penutup keseluruhan, susunan ketinggian yang sesuai serta penambahbaikan kepada system perlindungan dasar yang digunakan telah dicadangkan supaya Blok Labuan dapat bertindak sebagai penghalang ombak yang lebih berkesan dan dapat tahan lama.

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LIST OF SYMBOLS

v	Speed
W	Wavelength
P	Period

LIST OF ABBREVIATONS

ASTM	Amerian Society for Testing and Materials
ACD	Admirality Chart Datum
CD	Chart Datum
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
LSD	Land Survey Datum
SWL	Still Water Level

CHAPTER I

INTRODUCTION

1.1 General

The coastal area is a transitional area between land and sea. These areas are often attracted by people with the daily activities, from recreational one through to activities economic related such as port construction. It has a potential to become a developing area, especially where there are related to commercial, agriculture, industry and tourism carried by resident or authorities nearby.

The coastal area is characterized by its own ecosystem with wildlife and habitat functions of each nature are closely aligned with each other. Complex phenomena that occur on the beach are waves and tides. This situation interferes the daily activities of people in coastal areas, especially those related to tourism and trade. Other than that, it can indirectly lead to coastal erosion that can damage the natural habitat and structure that have been built in that area.

Therefore, the use of coastal engineering structures is important to prevent the phenomenon that may affect human daily activities. The uses of wave barriers, piling,

groin, and others are examples of coastal defence structures that commonly used to protect or at least reduce the damaging effect on the beach.

1.2 Coastal Line in Malaysia

As an ocean surrounded country, Malaysia has a long coastline, where the size and the distribution are as in **Figure 1.1** below:

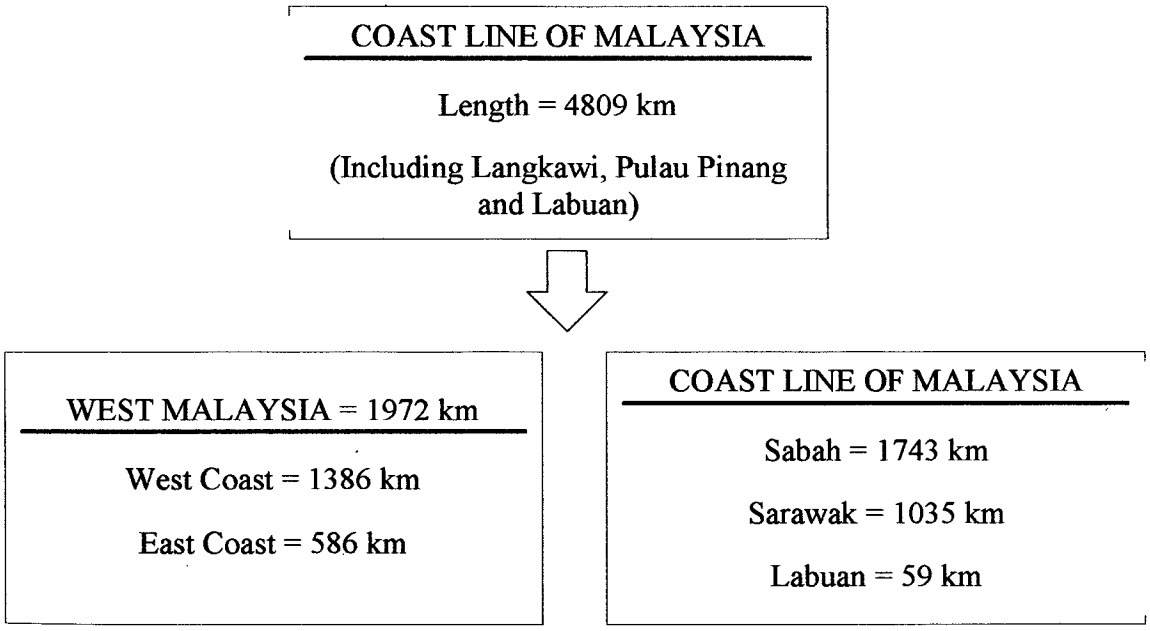

Figure 1.1 Coastal line in Malaysia (Faridah Jaafar Sidek, 2009)

From the total length of coastline in Malaysia, 4809 km, 29 percent or about 1400 km from the total length exposed to the phenomenon of erosion. Along 232 km if the coastline is at a critical point, 221 miles at a moderate level and the remaining about over 946 km are in the normal level.

1.3 Coastal Defence Structures

Coastal defence structure is a construction erected on the beach to prevent and break the waves. The main functions of coastal protection structure are to reduce the impact of wave and dissipate energy to create more tranquil waters.

Nowadayas, various types of coastal defence structures are often used such as types of floating breakwaters, stack stones, breakwater wall, composite breakwaters and also porous breakwaters. Selection of appropriate coastal defence structure provides a great influence in preventing high wave energy approaching the beach thus and lead to a more tranquil wave.

In addition, the coastal areas are also a complex area and thus the solution used to protect the shoreline are varies depending on the sites condition. In other words, the coastal areas have unique and different hydrodynamic characteristics.

Technical knowledge on the types of coastal defence structure is not the only thing required when selecting and designing, but it is also important in the process of construction and maintaining the structure. Therefore, the first action needs to be considered by engineers, is to identify the weaknesses and advantages of each type of coastal defence structures and to study the geography and hydrography effect on coastal areas.

1.4 Problem Statement

Coastal defence structures help in preventing coast erosion or at least minimise the impact. However, this structure has a certain life span of effectiveness where it depends on the type of structure and the factors of wave resulting in an area. Often the structure of a coastal defence failed prematurely in its effectiveness and this certainly

endangers the protected areas. One of the important elements of the structures that should be emphasized is to avoid a premature failure of the bed protection layer.

Waves and currents that hit the coastal defence structures can eventually lead to erosion and scour at the base of the structure. For a long time, this erosion and scour will cause the structure to be less effective as a coastal defence system. Therefore, bed protection is important as one of the criteria that should be well planned before the construction start. Failure of bed protection to works in accordance with planning policy contributes to the failure of the structure and result in loss of construction cost.

For many years, coastal engineers have realized that the effect of scour and erosion, if not monitored will be the main cause of structural failure, especially to the structures located near the shallow water (Eckert JW, 1983).

1.5 Objectives of the Study

This study aims to identify the impact and the function of the actual bed protection of coastal defence structures on selected area, which is Pantai Punggur, Batu Pahat, Johor. Factors that influence the effectiveness of bed protection such as wind, wave and soil characteristics will be described in order to define and study the level of suitability of the structures installed. This study will also identify whether there is any other reasons besides the failure of bed protection.

Hence, with the data and information obtained, a conclusion is made. In addition, suggestions will be also provided to overcome the problems on of bed protection of a coastal defence structure.

In order to achieve the targeted aim, the objectives in this study are as listed below:

1. To understand and identify the impact and the actual function of bed protection installed together with coastal protection structures.
2. To study the coastal hydrodynamic conditions such as profile waves, tidal water level and type of shoreline for the selected area.
3. To study the factors that caused the failure of bed protection.

1.6 Scope of Study

The scopes of this study are as follows:

1. Select the study area.
2. Identify the existing coastal defence structures built in the study area.
3. To define problems related to bed protection that causes failure of structures.
4. Analysis on the data obtained for selected area.

1.7 Significance of the Study

The coastal areas in Malaysia have become one of the fastest growing areas in course of trade, tourism and leisure. The beaches in Malaysia are unexceptional in this case where the coastal areas in Malaysia also well. Due to rapid development along the coastal area, the problem such as coastal erosion eventually occurs. In order to overcome the shortcoming, coastal engineers build the coastal defence structure to reduce wave impact and thus prevent the coastal erosion.

As mentioned in **Section 1.3** that the bed protection is an important element to ensure the stability of a coastal defence structure. Thus this study is very important to identify the problems and the factors that caused failure of the bed protection.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Previously, several studies have been conducted on the bed protection for coastal defence structures. These studies either in general or only focuses on one area. They discussed various types of bed protections that suitable as coastal defence structures and also to identify the failure factors of the bed protection.

However, differences in profile for coastal areas, such as sandy or muddy beaches like those in Malaysia makes it difficult for researchers to thoroughly study of the effects of varying coastal erosion. Due to this, a separate study should be conducted for each coastal area where the system is planned to be implemented. It is required as the information needed varies for every coastal area.

2.2 Types of Coastal Defence Structures

2.2.1 Seawall

Sea wall as in **Figure 2.1** is a strong structure and a vertical structure that works to protect coastal areas from the effects of strong waves. While in areas with low wave energy levels, it is used to separate land areas of the coastline. It is used and constructed together with other materials such as piles of steel, concrete blocks, gabion and timber piles.

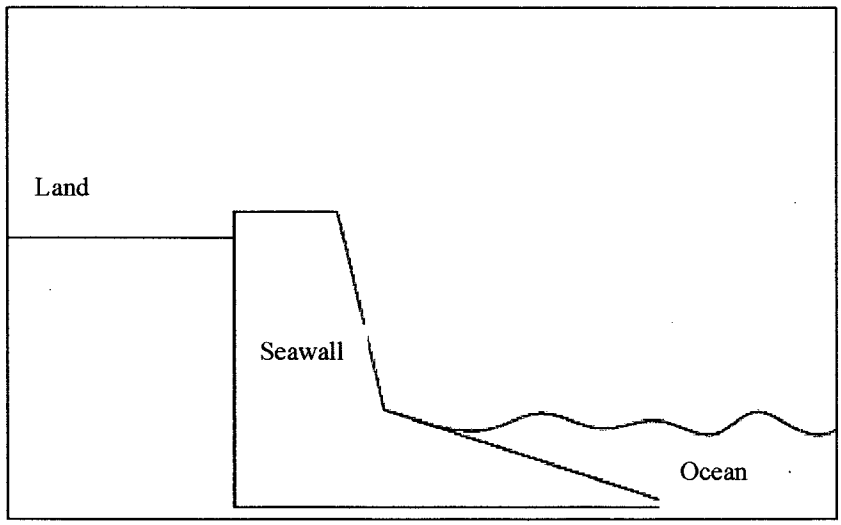

Figure 2.1 Sea wall

2.2.2 Revetment

Revetment is a form of a layer that is installed directly on the beach slopes, fortress or embankment to protect coastal areas from wave energy and strong streams.

These structures are built to sustain the use of existing coastal areas, serve to maintain the use of existing coastal areas and also serve to protect the slopes on the beach. It may be built covering the slope surface as a whole or in porous to allow water to run through after the wave energy is dissipated. **Figure 2.2** shows the revetment structure built on the beach.

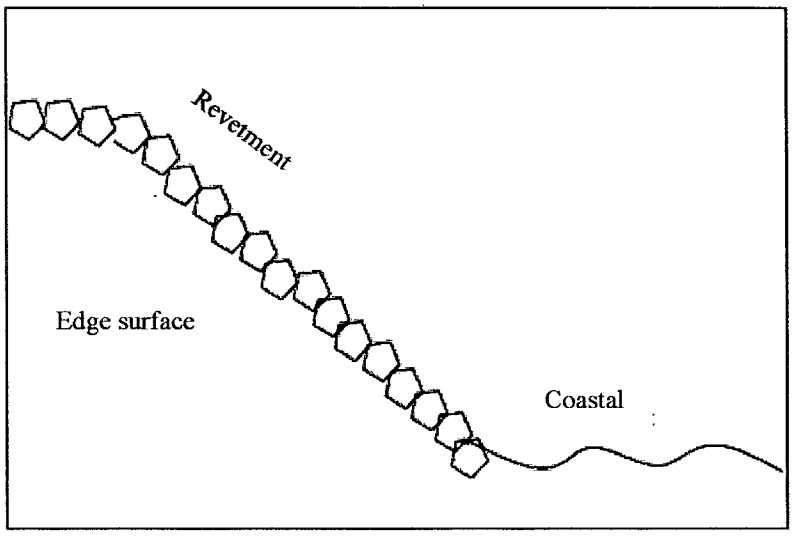

Figure 2.2 Revetment

Revetments are usually built of armorstone for areas exposed to high wave energy or riprap for the environment of low energy waves. They are built with a combination of small stones and geotextile layer which acts as a filter and the bottom. Both of these layers provide on bed protection structure and allow water to flow past the structure. It also supports the entire structure on it to be more stable.

2.2.3 Groin

Groin is a coastal stabilizing structure which is an oldest and commonly used. It is construction which extends perpendicular to the beach. Usually they are built in series and serve as a trap or retaining sand and protect coastal areas that lie between the series. As in **Figure 2.3** where the offshore drift will bring particles together and next it will get stuck in the groin that leads to the direction waves and form reclamation.

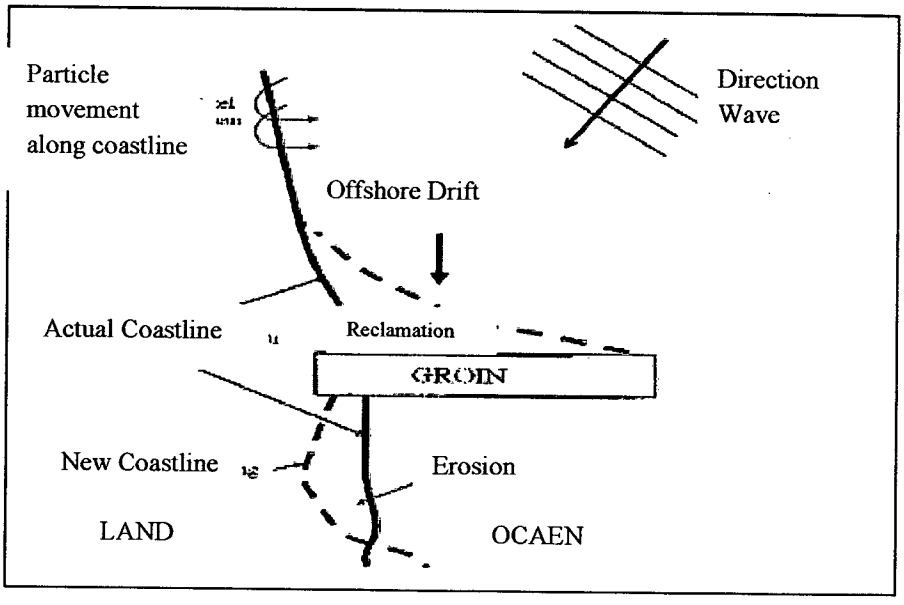

Figure 2.3 Effects of Sediment Movement around the Groin

2.2.4 Breakwater

Breakwaters are structures that constructed generally parallel to the coastline. It works to mitigate wave energy approaching the protected coastal area. There are two types of breakwaters which are the breakwater that connected to the beach *(shore connected)* as shown in **Figure 2.4** and also a separate breakwater to the beach *(offshore)* as shown in **Figure 2.5**.

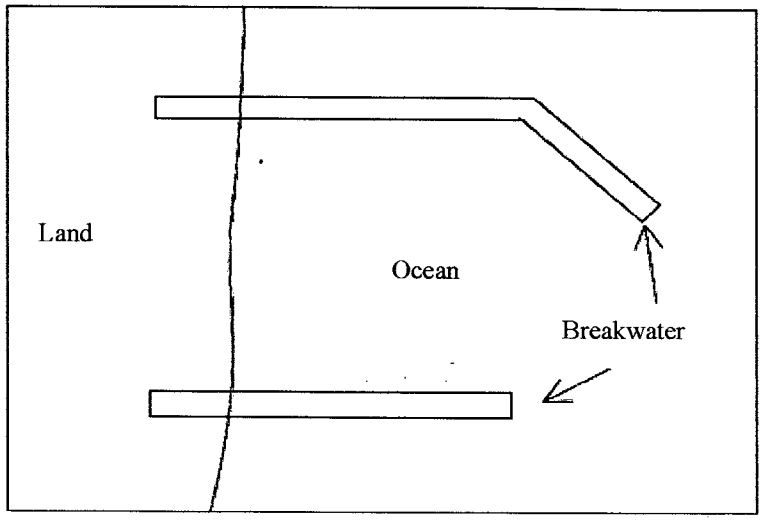

Figure 2.4 Connected Breakwaters

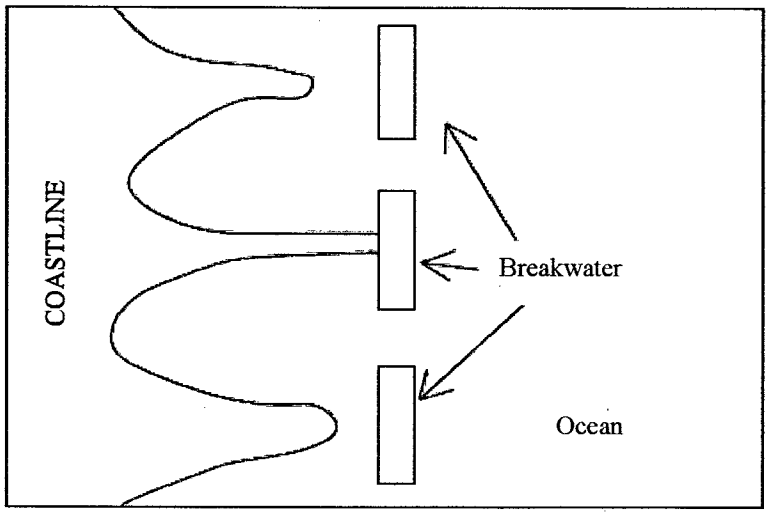

Figure 2.5 Separate Breakwater

2.2.5 Bed Protection using Geotextiles

In the construction of coastal structures, geotextile used as a filter, as a separation tool and also as reinforcement of the soil structure. The often used filter is the type of filter that allows water to flow through it. However, this filter normally trapped the sand or soil particles as shown in **Figure 2.6**. A separation part is installed at the base of the structure to prevent the materials from mix up example a mix up of a weak soil layer (*subgrade*) with a layer of strong aggregates. It is also used as reinforcement for road paving and the retained movement of the lateral embankment constructed on soft ground.

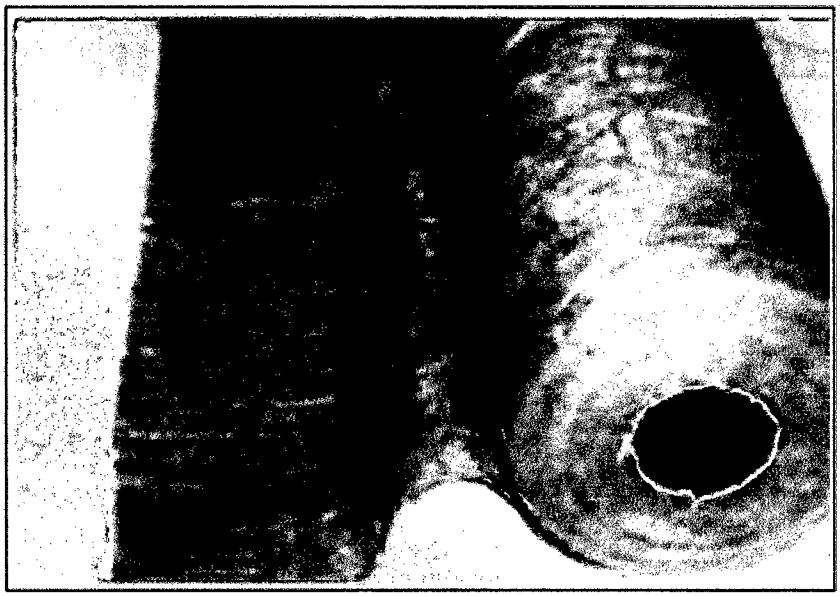

Figure 2.6 Non-Woven Geotextile (www.geofabrics.com, 16/4/2010)

Geotextiles used in coastal structures must be permeable so that it can reduce the hydrostatic pressure resulting from wave energy and also the movement of ground water. To increase the effectiveness, the geotextile must be designed according to grain

size rocks, ground water level and wave conditions for particular areas. **Figure 2.7** shows the cross section of geotextile installation as a bed layer for coastal structure. It also must be durable and has a good filtering ability for long lasting. (Whiteneck L.W.;Hockney L.A, 1989).

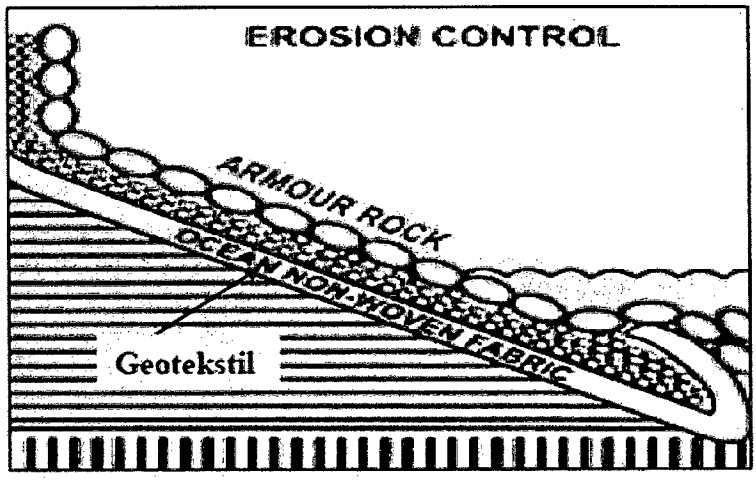

Figure 2.7 Position Geotextile of Coastal Erosion Defence Structure as a Bed Layer

2.2.6 Bed Protection in Wall Waves (*Seawall*)

Engineer has to consider that the wave wall built will minimised the reoccurrence of erosion. A simple rule to be followed is to dissipate wave energy in the horizontal rather than vertical. Particular attention should be given to the weak part of the whole structure especially at the base of the wall.

One of the types of wall is composed of a sloping apron with two curved wave wall, one on the water (seaward) and one in the land (landward) as shown in Figure 2.8 and Figure 2.9. The bed of this structure is covered by sand beaches. This apron has a

ratio of 3:1 angle and constructed using 200mm thick concrete locked block overlay 100mm drained aggregate (pea shingle drainage). The loss of the materials at this structure is avoided by using plastic fabric filter.

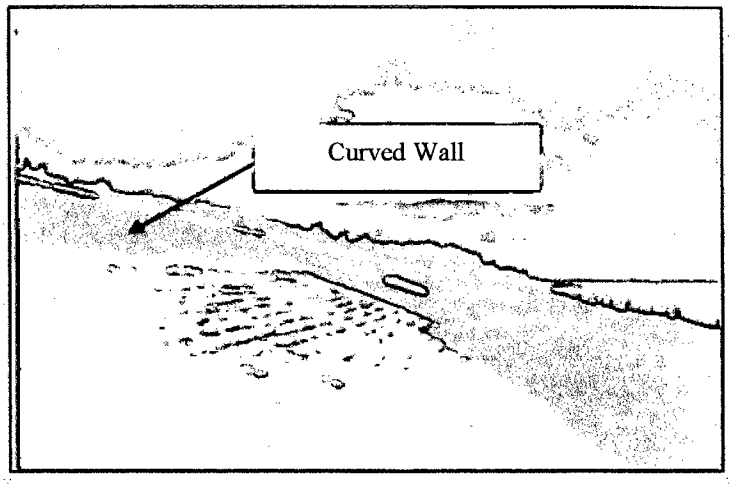

Figure 2.8 Curved Wall of Bed Protection (Thorn,R.B., and Roberts, A.G, 1981)

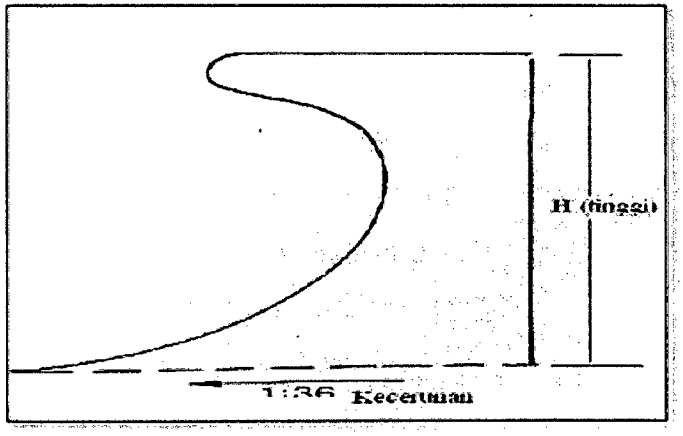

Figure 2.9 Shape Dimension Curve Wall of Bed Protection (Thorn, R.B., and Roberts, A.G, 1981)

2.2.7 Bed Protection Using Revetment

The engineers realized that the use of wave wall is costly, so other alternative such as revetment was selected. Different from wave wall, wave energy that affected the coastal defence structure will be absorbed by the revetment. Protection by revetment is also known as water permeable protector (*permeable sea defences*).

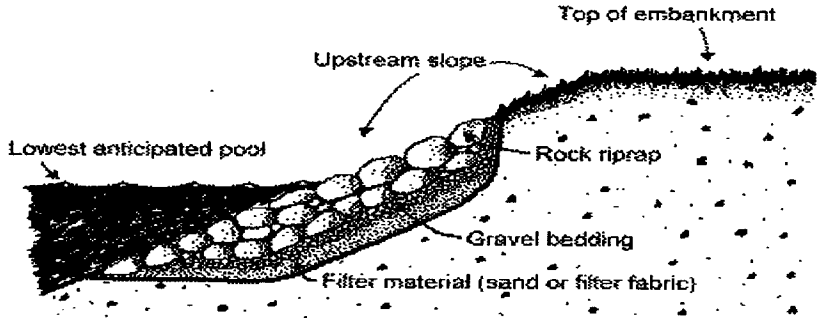

Figure 2.10 Grouted riprap (Thorn, R.B., and Roberts, A.G, 1981)

Rock riprap consists of a heterogeneous mixture of irregular shaped rocks placed over gravel bedding and a sand filter or geotextile fabric. The smaller rocks help to fill the spaces between the larger pieces forming an interlocking mass. The filter prevents soil particles on the embankment surface from being washed out through the spaces (or voids) between the rocks. If the riprap is sparse or if the filter or bedding material is too small, the filter material will wash out easily. But this problem can be overcome by the use of gabion cages of steel wire to wrap the rock that is not easily moved by streams and waves. **Figure 2.11** and **Figure 2.12** show the revetment installation at Kedah and Malacca.