

OVERVIEW OF COASTAL RECLAMATION PROJECTS IN MALAYSIA

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ABSTRACT

In the past two decades or so, there has been an increase in the number of coastal land reclamation projects for commercial, industrial, residential and tourism development in many of the more developed coastal areas of Malaysia. The success of any coastal reclamation project is strongly dependent on sound planning and design practices, covering both the engineering and non-engineering aspects. Engineering considerations in the planning and design of coastal reclamation projects are discussed while potential environmental impacts are elaborated. Some of the negative impacts include coastal erosion, loss of mangroves/wetlands, impedance of natural drainage and damage to marine eco-system.

The main regulatory measures instituted by the Government to control and regulate the planning and approval of coastal reclamation projects in this country are the Environmental Quality Act (1987), the General Administrative Circular No. 5 of 1987 issued by the Prime Minister's Department and the 'Guidelines on erosion control for development projects in the coastal zone' approved by the Cabinet in Jan. 1997. Apart from ensuring the proper planning and implementation of coastal development projects, it is also hoped that the implementation of these regulatory measures will obviate the need for expensive coastal protection works in the future.

1. INTRODUCTION

Malaysia has a total land area of 329,750 km², comprising of Peninsular Malaysia (131,590 km²) and the states of Sarawak (124,449 km²) and Sabah (73,711 km²). The corresponding lengths of shoreline for the three regions are 1970 km, 1040 km and 1800 km respectively. The east coast of Peninsular Malaysia comprises mainly sandy beaches while the west coast is made up of coastal plains formed from marine clay, occasionally interspersed by pockets of sandy beaches hemmed in between rocky headlands. The coastlines of Sabah and Sarawak comprised roughly equal proportion of sandy and muddy formations.

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The coastal zone of Malaysia which support a major portion (70%) of the population, is rich with natural resources, and is the center of economic activities: urbanisation, agriculture, fisheries, aquaculture, oil and gas exploitation, transportation and communication, recreation, etc. Of the coastal regions, the west coast of Peninsular Malaysia is most developed socio-economically, with 57 percent of its length under agriculture and 21 % under housing, transportation and recreation facilities.

In 1970, urban areas accounted for 27% of the total population but this has increased to about 40% in 1990. The urban population is expanding at a rate of 4.2%. One could expect more than 50% of the population to be resident in urban centers by the year 2020. Many of the large population centers are located in coastal areas, typical examples are Penang, Melaka, Johor Bahru, Kuantan, Klang, Kuala Terengganu, Kota Bahru, etc.

On the economic front, the structure of the Malaysian economy is also undergoing rapid transformation. In 1980, the manufacturing sector accounted for 20.5% of the Gross Domestic Product (GDP) but this has increased to 27% by the year 1990. With an estimated growth rate of about 10% per annum, the manufacturing factor is expected to account for 37% of GDP by the year 2020. Many of the industries are located in coastal cities to facilitate export and to tap the labour pool in these urban centers.

Population expansion and industrialisation are the two main factors that have contributed to the rapid growth of any coastal cities, resulting in an escalating demand for prime land. The wide shallow waters that abut the coastline become the prime target for reclamation. The financial advantage of coastal land reclamation is easily demonstrated considering the current market value of prime land in coastal cities and the construction cost for coastal reclamation. It is also due to the same reason that coastal cities such as Penang, Melaka, Labuan became the pioneers of coastal land reclamation projects.

2. ENGINEERING CONSIDERATIONS

Coastal reclamation projects are major engineering undertakings involving substantial cost outlay. A Typical project development goes through several well defined phases such as project identification and conceptualisation, investigation, feasibility study, design, construction and post - project maintenance. A good understanding or knowledge of the coastal processes and the related marine eco - system is therefore required in order to arrive at the most cost effective and environmental friendly solution.

The layout planning of any coastal reclamation project should give full considerations to coastal and hydraulic characteristics of the area. For this purpose, observations of offshore and nearshore wave conditions, bathymetric information, tides, etc. are required. The correct siting of platform level is crucial to the functional performance of the reclamation works.

2.1 Types of Coastal Reclamation

There are basically two types of coastal reclamation. These are the island type and peninsular type. The former is in the form of a reclaimed artificial island detached from the existing shoreline while the latter is a shore connected reclamation. While previous efforts on coastal reclamation have concentrated on the peninsula type of reclamation, the relative advantages of island reclamation in terms of environmental conservation have increasingly been recognised.

Table 1 compares the relative merits and demerits of the two types of coastal reclamation. Generally, the island reclamation type offers more advantages in term of reduced adverse environmental impacts, except that extreme care has to be taken in designing the separating channel to obviate potential siltation and reduction in water exchange in the channel. On the other hand, there is a larger cost implication for project proponents using the island concept due to the need to site the development in deeper water. However, the deepwater water can be advantageous if the primary aim of the development is water-dependent such as ports and marinas.

2.2 Reclamation Techniques

Several techniques and methods exist to carry out coastal reclamation, amongst which reclaiming at an area where the sub-soils are extremely soft forms a special case. This is particularly important because most of the proposed coastal reclamation works are located along the west coast of Peninsular Malaysia where the sub - soils consist of several meters of very soft marine clay. The principle two techniques in such a case are:-

- i) Excavation of soft soil layers (e.g. for the Chek Lap Kok airport in Hong Kong approximately 50,000 cubic meter of soft clays were removed after which marine sand was utilised to create a firm base for the infrastructural works).
- ii) Improving the specific properties of soft layers (e.g. Changi airport in Singapore has been claimed directly on top of layers of very soft clay. These layers were improved by installing vertical wick drains in combination with surcharge loads to shorten the period for settlement and to accelerate the increase in shear strength).

The choice of which of the two principle techniques to adopt will be mainly based on available funds (cost) and on the time constrains to the overall construction period (planning). The technique whereby the clay layers are excavated is evidently more costly initially but the benefits are such that infrastructural works can immediately start since the soft soil layers are replaced by a solid mass of sand whereby little or no remaining (differential) settlement will occur.

The technique of placing sand directly onto existing marine clay and subsequently treating the soils structure so formed by ground improvement methods i.e. vertical drains and surcharging will initially be less costly but because of the prolonged waiting period (for settlement and increase in shear strength etc.) before infrastructural works can commence, will probably be less feasible if the land is required quickly for construction.

3. CURRENT PROGRESS IN COASTAL RECLAMATION

Coastal land reclamation for urban use is a relatively new development in this country. Prior to the 1970's, there was hardly any work on coastal reclamation other than some small scale reclamation work in conjunction with the construction or expansion of port facilities. Even in other countries around the world coastal reclamation has historically been associated with port and harbour projects. The construction of artificial islands was spearheaded by Japan for a variety of uses ranging from power plants to airports, the latter being exemplified by the Kansai International Airport. Some of the prominent examples of reclamation works that have been carried in other countries are as shown in Table. 2.

On the local front, coastal reclamation for housing and industrial uses came into significance after 1970's as a result of accelerated urban development and the rising cost of land in some major coastal cities. To date, many small scale reclamation projects have successfully been implemented in various parts of the country such as Penang, Malacca, Labuan, Langkawi, Kota Kinabalu, either as public sector or private sector projects. Recently however, several states have embarked on massive reclamation projects along their coastline to augment their land bank and to be able to carry out large scale development projects. Table 3 shows the list of large scale coastal reclamation works that have so far been proposed in the various states. All these large scale reclamation projects are still in the planning stage and macro E.I.A.s (which include hydraulic studies) are now being carried by the respective states to determine the possible environmental impacts and to identify the necessary mitigative measures. The hydraulic studies which are being carried out is also supposed to fine tune the configuration and layout of the proposed reclamation works so as to minimise the adverse impacts.

4. OFFSHORE SAND MINING FOR COASTAL RECLAMATION

Coastal reclamation requires a lot of suitable fill material and the most commonly used fill material is sand. Traditionally, both land based material and marine sand have been used for reclamation in Malaysia. However, at the National Development Council Meeting held on June 1996, it was decided that land based material will not be allowed to be used as fill material for reclamation. This effectively means that all future reclamation works will have to be carried by using marine sand.

For all the reclamation works that have been described earlier, it has been estimated that the total amount of sand required is about 2 billion m³. Preliminary estimates of the total sand deposits in the Malaysian waters indicate that there are more than 8 billion m³ of sand available. However, these sand deposits are not evenly distributed and are found to be concentrated mainly on the east coast of Peninsular Malaysia. Most of the larger reclamation projects are sited along the west coast of Peninsular Malaysia and it is very uneconomical to transport the sand from the east coast to the west coast. Due to this reason, some of the developers especially those from Perlis and Kedah are considering importing sand from neighbouring countries for their reclamation projects.

Several project based studies (e.g. in Malacca and Negeri Sembilan) have been carried out to locate offshore sand deposits by individual project developers. However these studies were conducted to meet individual project requirements and hence lack the comprehensiveness of an overall national level study. In the Straits of Malacca reconnaissance studies conducted by the Geological Survey Department have indicated the presence in certain areas between the islands of Penang and Pangkor and also in certain areas off the coasts of Selangor, Negeri Sembilan, Malacca and Johor as shown in Fig. 1.

In view of the urgent need to identify the available sand sources in the country, the Government is now conducting a National Offshore Sand Resources study. The purpose of the study is to establish an inventory of offshore sand sources that are available and are economically exploitable with minimal environmental impacts. This study will be conducted by the Geological Survey Department and it will be carried out in several phases. The first phase will concentrate on the west coast of Peninsular Malaysia, bordering the coasts of Perlis, Kedah, Pulau Pinang, Perak, Selangor, Negeri Sembilan and Malacca.

5. IMPACTS OF COASTAL RECLAMATION PROJECTS

Land reclamation and sand mining activities which are not properly planned can cause adverse impacts to the coastline. Land reclamation alters the coastal land form and this consequently leads to a change to the existing hydrodynamic regime which in turn may cause erosion or siltation to the adjacent coastline. Sand mining if carried out near the coastline or in the surf zone may affect the existing sediment transport pattern and wave characteristics which may also lead to adverse impacts on the coastline.

5.1 Adverse Impacts due to land reclamation activities

Some of the typical adverse impacts which may occur due to land reclamation activities are as follows :-

- a) complete or partial loss of recreational beaches
- b) interference with the normal coastal processes resulting in erosion or siltation

- c) interference of the natural drainage of the hinterland areas
- d) destruction of mangrove forests
- e) pollution of coastal waters
- f) complete or partial loss of aquaculture
- g) siltation of navigation channels and fish landing harbours

5.2 Adverse impacts due to sand mining activities

Some of the typical adverse impacts which may occur due to sand mining activities are as follows :-

- a) erosion of beaches from drawdown due to the backfilling of the dredge pit
- b) interception of the longshore sediment transport by the dredged pit, which results in erosion on the downdrift side
- c) removal of protection afforded by offshore banks, which leads to bigger waves impinging on the coast;
- d) changes in the waves refraction pattern, which concentrates waves energy at a particular place; and
- e) pollution of coastal waters
- f) destruction of aquatic eco-systems and adverse effects on aquaculture systems.

6. INSTITUTIONAL FRAMEWORK AND REGULATORY MEASURES

In order to ensure that the development projects in the coastal zone are carried out in a sustainable and proper manner with due consideration to the consequences of the possible adverse impacts, the Government has institutionalised several measures such as :-

6.1 General Administrative Circular No. 5 of 1987

This Circular requires all proposed development projects in the coastal zone (which includes land reclamation and sand mining) to be referred to the Coastal Engineering Technical Center (CETC) of the Coastal Engineering Division at the Department of Irrigation and Drainage (DID) for comments.

6.2 Environmental Quality Act 1974 (revised 1987)

This Act spells out a list of development activities which require mandatory submission of EIA reports for prior approval of the Department of Environment (DOE).

Coastal reclamation involving an area of 50 hectares or more is captured under Activity 4 of Environmental Quality Act, 1974 Environmental Quality (Prescribed

Activities) (Environmental Impact Assessment) Order 1987 where an EIA study is mandatory under the law.

Similarly, sand mining activities involving an area of 50 hectares or more are captured under Activity 11 (c) of Environmental Quality Act, 1974 Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 where an EIA study is mandatory under the law.

6.3 Guidelines on erosion control for development projects in the coastal zone

Apart from assisting the DID in the implementation of the General Administrative Circular No. 5 of 1987, the guidelines also aim to ensure the proper planning and implementation of coastal development projects to obviate the need for expensive coastal protection works in the future and to ensure sustainable development of the coastal zone.

For coastal reclamation projects, the Guidelines state that

- i) All reclamation projects (irrespective of whether an EIA is required or not) should be subjected to a hydraulic study to evaluate the adverse impacts. The study should also capture the hydrodynamics and morphological changes using a modeling approach. If the hydraulic study shows any adverse impacts then the developer should propose feasible mitigative measures.
- ii) Provision for proper discharge for the drainage or flood flows from the hinterland
- iii) For the reclaimed shoreline, there should be a setback of 60 meters measured from the landward edge of the Mean High Water Spring. However, if coastal erosion protection works are provided, the developer needs to provide a sufficient setback to be agreed upon by the CETC for the maintenance of the structures. This setback zone should also be equipped with a service road built by the developer for public access to sea frontage.

For sand mining activities, the Guidelines state that :-

- i) As a general rule, sand mining is not permitted in nearshore areas which are less than 1.5 km from the Mean Low Water Line or 10 meter water depth (from Lowest Astronomical Tide) whichever is further from the shore. This is to ensure that this will not result in any major disruption to the delicate balance of sediment movement in the nearshore littoral cell.

- ii) However, if it is not possible to comply with the above requirement due to technical, practical or economic reasons, a hydraulic study should be conducted to demonstrate that the sand mining operation at the proposed site would not lead to adverse impacts on the coastal processes, aquatic eco-systems and the stability of the adjacent shorelines.
- iii) Notwithstanding the above, if there is an existing study which shows that any sand mining activity in a particular area will have adverse impacts, all mining activities in these sensitive areas shall be prohibited even if the general guidelines for sand mining have been adhered to.

6.4 Process of Application for Coastal Reclamation Projects

Under the Federal Constitution land is a state matter and hence all reclamation projects require the approval of the State Government before they can be implemented. Generally an application for land reclamation is submitted to the Local Authority or State Government which then seeks the views and comments from the various Government Agencies before submitting to the State EXCO for approval. The flow chart for processing of land reclamation applications is shown in Fig.2.

The approval for sand mining falls under the purview of either the Federal or State jurisdiction, depending on the location of the operation. All land, including the foreshore up to 3 nautical miles seaward from the low-water mark, is controlled by the state. The seabed and water beyond this limit, up to the continental shelf boundary, falls under federal jurisdiction. Therefore, if the location of the sand mining area is within the 3 nautical mile limit, then the applications will require the approval of the State EXCO. Otherwise, it will require the approval from the Ministry of Land and Cooperative Development. The flow chart for processing of sand mining applications is shown in Fig.3 and 4.

7 CONCLUSIONS

Coastal reclamation which has been carried out for some time in Malaysia yields valuable land space for a variety of uses and is expected to be on the upward trend. The success of such projects depends on sound engineering practices and adequate attention to potential environmental impacts. Engineering considerations for the planning and design of coastal reclamation projects include layout planning, simulation studies, protection against erosion, geotechnical considerations, sand sourcing, etc.

Coastal land reclamation projects can result in significant impact on the coastal environment such as loss of mangrove and wetlands, damage to sensitive marine habitat, coastal erosion and impedance of hinterland drainage. Planners and designers should

give adequate consideration to avoid or minimise such potential impacts and implement the necessary mitigative measures, where required in a proactive manner.

References :-

- 1) '*Coastal Reclamation in Malaysia*' by Dato' Ir. Hj. Shahrizaila bin Abdullah & Ir. Dr. Hiew Kim Loi
- 2) '*Kedah Coastal Reclamation : A challenge in Development Planning, Strategy and Implementation in Malaysia in Malaysia*' by Ir. Dr. Lee Say Chong
- 3) '*Guidelines For Erosion Control For Development Projects In The Coastal Zone*' by the Department of Irrigation and Drainage

Table 1 : Comparison of the Types of Coastal Reclamation

Item	Type of Coastal Reclamation	
	Island	Peninsula (shore connected)
Characteristics		
Planform	Shore Detached	Shore Attached
Average Depth	Deeper	Shallower
Protection of Reclaimed Shoreline	More Elaborate	Less Elaborate
Separating Channel	Yes	No
Environmental Impacts		
Protection of Mainland Coastline	Yes	Yes
Potential erosion / accretion along adjacent coastline	Yes	Yes
Mangroves	Likely to remain if tidal flushing is adequate	Degradation is very likely
Waste Water	tendency for waste water to accumulate in the separating channel if tidal flushing is inadequate	Discharge directly into the sea
sea water frontage	sea frontage is lessened	visual impairment and severance of the “proximity to sea” amenity
access for fishing boats	existing access is maintained (might require periodic dredging)	may require relocation of fish landing sites

Table 2 : Comparison of Large Scale Coastal Reclamation Projects in Other Countries

Location	Area (ha)	Average Water Depth (m)	Fill Quantity (m ³)	Project Cost (RM)
Kansai International Airport, Japan	511	18	200 million	10.2 billion
Chek Lap Kok Airport, Hong Kong	200	4 - 6	> 70 million	N.A.
West Coast of Taiwan	2,200	3	N.A.	N.A.
Jurong Island, Singapore	1,790	N.A.	N.A.	12 billion
North Jakarta Waterfront City Reclamation, Jakarta	8,750	shallow water coastal swamp	N.A.	3.3 billion

Table 3 : Large Scale Reclamation Projects That Have Been Proposed at various states *

Location	Area (ha)	Average Water Depth (m)	Fill Quantity (m ³)	Project Cost (RM)
Perlis Coastal Reclamation Project	2,430	2 - 4	N.A.	N.A.
Kedah Coastal Reclamation Project	16,300	2 - 4	N.A.	30 billion
Lekir and Bagan Datoh, Perak	12,400	N.A.	N.A.	N.A.
Negeri Sembilan	960	N.A.	N.A.	N.A.
Malacca	2,300	N.A.	N.A.	N.A.
West Coast of Sabah	3,760	6 - 10	490 million	12 billion

**The figures given here are only approximate and may change as more detail studies are being carried out*

Note : N.A. stands for Not Available