

CHAPTER 195

100 YEARS OF FORESHORE RECLAMATION IN SINGAPORE

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ABSTRACT

Singapore is an island republic with about 10% of her land area reclaimed from foreshore during the last century. In this Paper, past reclamation works are reviewed and possible future reclamation works are predicted.

1 INTRODUCTION

Due to its strategic location, Singapore has since its founding in 1819, been centre for trade and commerce, transportation and other activities in the region. The result was a rapid growth in population, from about 200 in 1819 to 2.5 million today, in a country with land area of only 636 km², inclusive of its 57 offshore islands and 53 km² of land reclaimed from foreshore (Information Division, 1986).

The resulting high population density has created a constant need to reclaim land from the foreshore for various development projects along the coastline, especially those related to airports, seaports, maritime and petroleum industries, housing, commerce and recreational parks. The calm wave environment and rather low tidal range (about 3 m) prevail along the coastline of Singapore, has enabled the reclamation works to be executed economically.

2 EARLIER RECLAMATION WORKS

Earlier foreshore reclamation works were mainly confined at the southern tip of the main island of Singapore, from Kallang Basin at the east to Tanjong Berlayer at the west. Total land area reclaimed before self-rule in 1959 was about 3 km².

The first early major foreshore reclamation works was the reclamation at the then Telok Ayer Bay about 100 years ago, for the construction of a link road between the then commercial centre at Singapore River and a new deep-water port at Keppel Channel. Fill material was obtained by levelling of 2 hills at Tanjong Pagar (Bogaars, 1956). Covering approximately 7 ha, the project took more than 8 years to complete.

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This reclaimed land was subsequently further extended and completed in 1915 with the formation of Telok Ayer Basin. A comprehensive map, drawn 82 years ago, showing earlier reclamation proposals along Singapore coastline was contained in Reith's Handbook to Singapore (1907).

Earlier reclamation works also include reclamation of 9 ha land at the present Container Terminal by the then Tanjong Pagar Land Company in 1880's, and reclamation along Keppel Channel in 1900's for the construction of seaport and shipyards.

At the conference of Kallang and Geylang Rivers, about 1 km² of land was reclaimed in 1930's for the construction of Kallang Airport. Seven million m³ of fill material was obtained from a hill situated some 6 km away from the site. Trains were used for the transportation of the fill material. This project took 4 years to complete. During the same period, the coastline from the mouth of Singapore River to the mouth of Rochore River was also reclaimed for the construction of an esplanade.

3 RECENT RECLAMATION WORKS

With the achievement of self-rule in 1959, and subsequently independence in 1965, various massive reclamation works were initiated to cater for rapid development in public housing, industry, commerce, recreation, air and seaport development, and for construction of express ways. To ensure that reclamation works can be executed without much hindrance, necessary amendments were made to the Land Acquisition and the Foreshore Ordinances in 1964.

Recent reclamation works are mainly carried out by three Statutory Boards as agents to the Government, namely Jurong Town Corporation (JTC), Housing and Development Board (HDB) and Port of Singapore Authority (PSA). Together, these three reclamation agents have reclaimed a total of about 48 km² land area, representing more than 90% of the total land area reclaimed from foreshore during the last 100 years. Since 1965, Singapore has been growing in land area at a rate of 8,000 m² per day (Radhakrishnan et al, 1983). About 285 million m³ of fill material was moved in these reclamation works.

Major reclamation works executed by the JTC, mainly for industrial development, are Tuas foreshore reclamation, Jurong Port extension, Loyang Reclamation, Senoko Reclamation, reclamation at Seraya Island, Ayer Merbau Island, Busing Island and Sakra/Bakau Islands. The JTC is now reclaiming a further 6 km² of land area off Tuas, a project scheduled to complete in 1988.

Reclaimed lands executed by the HDB are mainly for housing, commercial and recreational purposes. Since 1963, the HDB had reclaimed the entire south-eastern coastline of Singapore Main Island, from Changi at the east to the city centre at the south. These works had been executed in 7 major phases, in tune with public housing development schemes during which hills at Bedok and Tampines were levelled for the building of new towns. The HDB is now reclaiming 9.6 km² of foreshore area at Punggol, expected to complete in 1993.

During the last 20 years, the PSA has carried out reclamation works at 21 offshore islands for various purposes, including catering for recreational needs. At the main island, about 10 km² of land was reclaimed by the PSA, mainly at Changi, for the building of Singapore Changi Airport, and at Pasir Panjang, for the development of a seaport. Unlike JTC and HDB, fill for the reclamation works executed by the PSA was mostly dredged from seabed.

4 AVAILABILITY OF FILL MATERIAL

Main sources of fill material for reclamation works in Singapore are earth obtained by levelling of hills and seabed sand obtained by dredging.

Before 1974, fill used for reclamation was obtained entirely from levelling of hills, an operation carried out in phase with development of public housing and industrial estates. Borrow area for East Coast Phases III and IV Reclamation Project was subsequently converted into a fresh water reservoir (Wei, 1983).

As land source is rapidly diminishing in capacity, seabed sand is dredged as fill. For the reclamation of offshore islands, seabed sand was the natural fill material. Dredging of seabed has enabled ships with deeper draught to call at Singapore Port, the World's 2nd busiest port after Rotterdam.

During the last 100 years, nearly 165 million m³ of earth and 120 million seabed sand were moved to reclaim 53 km² of land.

5 SHORE-PROTECTION METHODS

When the reclaimed land is not used for wharf construction, shore-protection methods normally adopted for the reclaimed land are either revetment, or headland breakwaters or sandy beach.

Todate, more than 76 km of revetment was built involving at least 2.5 million m³ of granite blocks, while nearly 20 km of reclaimed coastline is protected by headland break-

waters. The latter is concentrated at the eastern part of Singapore Island, where the reclaimed coastline is mainly catered for recreational purposes.

The remaining 40 km reclaimed coastline is unprotected resulting in formation of sandy beaches wherever sand is used as fill. One typical example of which is the creation of artificial beach at Singapore Changi Airport, where favourable angles of wave approach to the coastline result in negligible littoral drift and thus a remarkable stable beach is formed (Pui, 1983). With mild wave environment prevails around the entire Singapore Island, it is advisable that the sandy beach concept be adopted wherever there is no space limitation for beach formation.

6 FUTURE RECLAMATION IN SINGAPORE

Future reclamation works in Singapore would be executed in deeper water as most of the tidal flats at the fringe of the main island had been reclaimed. It is estimated that another 70 km² of land can be reclaimed without much affecting the tidal flows around the island, as well as on limited seaspace for navigation and anchorage, and for submarine services.

As fill is not readily available in large quantity for future major reclamation works, research is now being done in local university on use of marine clay as fill (Information Division, 1986). Marine clay covers much of the seabed around the island. If it is found suitable as fill, future reclamation works could proceed with less imported fill.

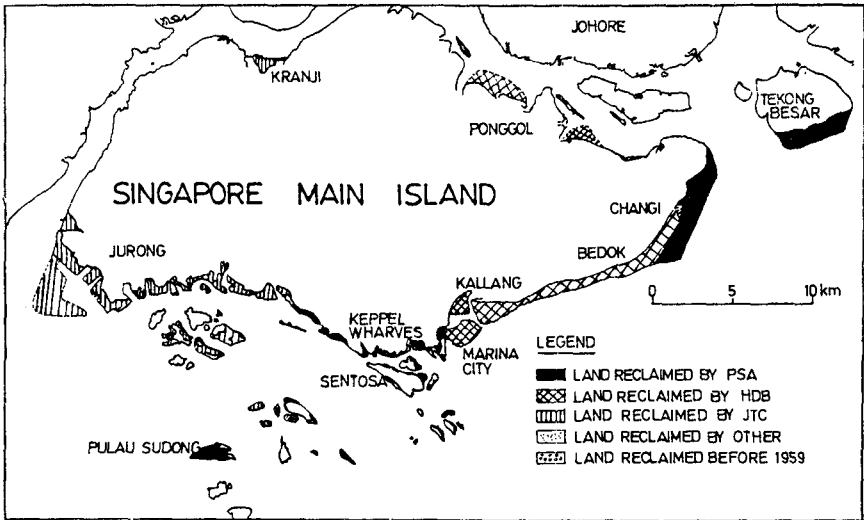
7 CONCLUSION AND RECOMMENDATIONS

In view of high population density, there is a constant need in Singapore for reclamation works in foreshore area for various development projects along the coastline.

Earlier foreshore reclamation works, commenced about 100 years ago, were mainly confined at the southern tip of Singapore Main Island. Works included reclamation for construction of road, and building of air and seaports.

Recent reclamation works are mainly carried out by three Statutory Boards as agents to the Government. Together, they have accounted for 90% of the land reclaimed from foreshore during the last 100 years.

Nearly 285 million m³ of fill material was moved to reclaim 53 km² of land area during the last century. As a result, there is little suitable fill source left for further reclamation. Research works are now being done in



RECLAMATION MAP OF SINGAPORE

local university to verify the suitability of marine clay as fill, a material found in abundant quantity in Singapore.

With mild coastal environment prevails around the Singapore Island, it is suggested that sandy beach concept be adopted as a form of coastal protection method to reclaimed land, wherever there is space for development of beach slope. Saving up to US\$1 million per kilometre is envisaged as compared with construction of revetment. Where littoral drift is significant, headland breakwaters can be provided to control the changes of the coastline.

Reclamation works in Singapore are envisaged to continue unabate as it is estimated that another 70 km² of foreshore could be reclaimed economically. This estimated area is more than the total land area reclaimed during the last 100 years.

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