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Offshore Deep Water Terminals

8.1 INTRODUCTION

The continuing worldwide demand for energy and raw materials creates a strong need for specialized bulk material ports able to accommodate a large deep draft vessel.

It has been found, however, that the conventional approach to creating an artificial deep water harbor, involving dredging of large quantities of seafloor materials and construction of breakwaters, in most practical cases can be prohibitively expensive. At the same time, only a relatively few existing ports are able to accommodate vessels with drafts exceeding 15 m, not to mention super carriers of the 27–28-m draft range.

Studies carried out worldwide indicate that the economics of bulk transportation in large quantities is such that the unit cost per tonne of transported material is reduced considerably with the use of larger ships able to carry superloads to terminals for further distribution. Consequently, deep water facilities able to handle a large deep draft vessel, such as supertankers for transporting crude oil and liquid natural gas (LNG) and superbulkers to transport dry bulk materials, such as coal, iron ore, and other have been constructed at many locations in the world. The key factor in the operation of these terminals has been utilization of very high-capacity loading/unloading technology. As discussed in Chapter 2, movement of millions of tonnes of liquid and dry bulk materials is best achieved through construction of deep water highly specialized terminals capable of handling very large ships with sizes in the range of 150,000–750,000 DWT. At these facilities the loading and unloading of cargo is carried out at very high rates (e.g., loading of up to 20,000 tonnes/h of dry bulk and 220,000 m³ of crude oil per day, with annual throughput of tens of millions of tonnes has been achieved).

The conventional approach to creating a new artificial deep water harbor, or deepening the existing harbor to serve a large deep draft vessel, in a great many cases appears to be cost-prohibitive. Sometimes, even if a deep water area can be found or created in existing waterways or ports, very often the environmental concern, combined with a lack of usable land and limited transporta-
tion networks, prevents the creation of a major new port complex.

The practice of the past 30 years clearly demonstrates that large quantities of bulk material can be effectively moved at low cost via offshore marine terminals not protected from the effects of environmental loads. At these facilities, the low berth occupancy due to rough sea conditions is compensated for by high rate of material handling. The high throughput is achieved by the construction of facilities designed to handle only one specific kind of cargo (e.g., coal, iron ore, LNG, or crude oil) and the use of very efficient high-capacity material handling technology.

In the case of a dry bulk loading/unloading facility, the technology includes utilization of fewer high-capacity conveyors, fewer stackers, reclaimers, and shiploaders or unloaders. The conventional traveling loaders have been replaced by slewing-bridge-type radial loaders that reduce substantially the cost of marine construction. Different types of machines that are used for handling of both the dry and liquid bulk materials are discussed by Ferguson (1981) and Soros et al. (1986).

Structurally, offshore terminals are not only site-specific but they are also different due to the type of operation they are designed to perform. Typically, dry bulk unloading facilities have been constructed in a form of piers designed to support traveling unloader(s) and conveyor systems that carry material to the land-based storage yard. On the other hand, most of the dry bulk loading terminals and liquid bulk loading/unloading facilities have been constructed in the form of a platform designed to support loading/unloading equipment, flanked by breasting and mooring dolphins. These facilities have been constructed far enough offshore where sufficiently deep water is found and no maintenance dredging is required. In some instances these terminals were located as far as 2000 m offshore to serve very large crude or dry bulk carriers.

These facilities have been linked to the shore either by a bridgelike trestle designed to support pipe lines or conveyor systems and to provide access to the terminal for lightweight vehicular traffic, or by submarine pipelines (Yaron and Shimon, 1982; Soros et al., 1986; Youndale and Shrivastava, 1986; Wright et al., 1987).

The seafloor area adjacent to the shores is termed a continental shelf. A continental shelf is relatively shallow and typically extends very far from the shores. At shallow locations, the approach channel(s) can be dredged to provide access for deep draft vessels. However, where the coastal regime is such that a dredged channel would soon silt up and, therefore, require steady maintenance dredging, the operation of the terminal can be cost-prohibitive. This problem was successfully overcome by construction of transhipment islands, located far enough offshore and designed to provide a berthing for large deep draft vessels. The islands also have been designed to provide sufficiently protected loading or unloading facilities for a smaller dedicated shuttle vessel(s) that can bring the cargo to and from the island.

The design and construction problems associated with offshore islands are beyond the scope of this work; this chapter is limited to discussion of some specific aspects associated with the design and construction of the offshore deep water marine facilities, such as piled and gravity-type dolphins, platforms, and piers. For discussion on offshore transhipment island, the reader is referred to Chesson (1980).

Naturally adequate onshore-based facilities are needed for handling the required amount of the transhipped material and a shuttle vessel(s). Optimal access to the offshore island is usually decided on the basis of economic studies (e.g., all-weather access, such as trestles, submarine pipe lines, or in some cases submarine tunnels in combination with well-balanced storage facilities both onshore and offshore versus larger