9.1 INTRODUCTION

A port is a dynamic system, growing and changing as the purpose it was constructed for changes. Nowadays, port authorities and terminal operators are increasingly seeking ways in which they can adapt existing port infrastructure to meet the changing demands of their markets. From an engineering point of view, the port is a system that comprises of miscellaneous facilities directed to the economically efficient and safe handling of cargo. When the type of cargo or transportation mode changes, the port needs to be modernized to be effectively adapted to the new updated cargo handling and hauling equipment, new types of vessels, ground transportation, and so forth.

During the last four decades the call for more effective port operation stimulated the development of new cargo handling methods and new cargo handling and hauling equipment, and also resulted in dramatic changes in ship size and shape.

The technological advances in transporting commodities by water transportation results in a new approach to planning, design and construction of new cargo handling terminals, and modernization of existing ports. At present, the “ideal” terminal is one that has sufficient flexibility of being adapted to the different types of cargo handling systems without substantial changes to its infrastructure. For this, the modern multipurpose marine terminal is usually designed for a uniformly distributed load of 50 kN/m² with consideration given to heavily concentrated live loads that are dependent on the chosen cargo handling and hauling equipment, which are often custom-made. In some instances, handling special cargos may result in very heavy loads; these loads, however, may be handled at specially designated areas, where the waterfront structure is designed to sustain these loads.

These terminals and their equipment must be adequately sized. However, it must be kept in mind that the life of the marine facility is rather long and terminals designed today must be expected to meet demands during their lifetime which cannot be foreseen. On the other hand, overdesigning can be very costly. Therefore, new ter-
Terminal planning and design must be properly balanced.

Many of the existing ports presently in operation worldwide have been built in post-World War II years. Naturally, these ports and their marine facilities have been designed to service comparatively small vessels and are equipped with less sophisticated and lighter cargo handling equipment. At that time, ports were designed for a maximum uniformly distributed load equal to 40 kN/m². Hence, to meet today's service requirements the load-carrying capacity of these facilities must be carefully reviewed in-service. Furthermore, most of the older facilities still in service have to struggle with problems such as those associated with insufficient water depth in front of the quay.

The spectacular growth of ship sizes, especially in bulk transport, and the development of new ship types such as container, roll-on/roll-off, car-carriers, and large ferry ships make many of the existing port facilities obsolete. Furthermore, larger and more powerful ships with increased draft and therefore less keel and propeller clearance approaching the berth with no tug assistance can cause considerable scouring damage, especially if the structure is built on an erodible foundation; this can undermine the quay wall base resulting in structural damage or unacceptable displacements.

Substantial scour in front of a sheet-pile wall may result in heavy irreversible over-stress of both sheet piles and the wall anchoring system. For a detailed discussion on this subject, the reader is referred to Tsinker (1995).

To avoid the adverse effects of seafloor erosion on the performance of waterfront structures, a greater depth must be created. Basic principles of structure modernization that applies to depth of water increase and associated relevant case histories are further discussed in this chapter. In addition to stability problems associated with seafloor erosion and increased loadings, the older structures typically suffer a deterioration of their structural components that reduces their ability to carry loads. Structural deterioration depends on material, quality of maintenance, exposure to marine environment, and degree of physical damages sustained by the structure from ship impacts, operation of cargo handling and hauling equipment, and others.

Normally, the old structure, if planned to be integrated or used in a new facility, should be rehabilitated. This should include an evaluation of its actual load capacity. This typically consists of an inspection of the structure and an engineering evaluation; where required, the existing structures must be structurally upgraded. This may include either structural repair/rehabilitation and/or the addition of new structural components to the old structure that in combination with the existing structure will create a new system able to serve new types of vessels and/or support new and heavier cargo handling and hauling equipment. Principles of structural evaluation of in-service marine facilities are discussed in detail in Tsinker (1995).

In some instances, the performance of existing soil-retaining structures (e.g., quay walls or sheet-pile bulkheads) can be improved by reducing the lateral soil pressure (exerted on them) and/or modifying a soft foundation soil to achieve better bearing capacity or increased passive soil pressure. Practical methods used for the rehabilitation of distressed foundation soils and reducing lateral soil thrust on soil-retaining structures are given in Tsinker (1995).

Last but not least, where highly powered vessels, particularly those with side thrusters, are planned to be used, the marine structure must be protected from scour. Detailed discussions on scouring effects on seafloors produced by ship propellers and basic scour protection methods are given in Tsinker (1995).

The following two sections are dedicated to the discussion of the basic methods used