Chapter 1

Introduction

Ocean and coastal engineering is the application of science in an ocean and coastal environment in order to meet the needs of the people. Although one of the important needs of people is the economic feasibility and the environmental impact of ocean and coastal projects, this particular aspect of ocean and coastal engineering will not be addressed in this review. This does not reflect an attitude that is intended to diminish the importance of these two very important aspects of ocean and coastal engineering, but rather a lack of expertise in reviewing these two important topics. This limited review will, instead, focus on the physical and mathematical aspects of ocean and coastal engineering.

One scenario for the engineering design of an ocean or coastal project is given in Fig. 1.1. Each element of the design begins with a statement of the principles of physics that govern that particular element. These principles of physics are then translated into mathematical problems that must then be solved

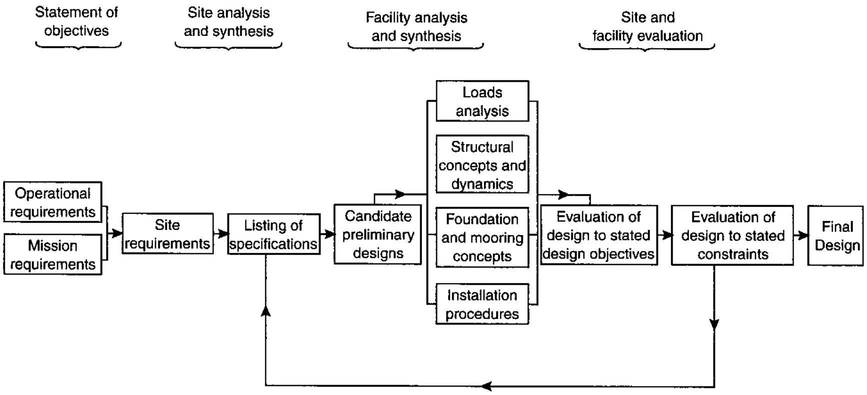

Fig. 1.1. Scenario for an ocean or coastal engineering project.

either analytically or numerically. If a solution is obtained, it then remains to interpret these results physically. For this reason, the pedagogy in this review is to begin each problem analyzed by a statement of the principles of physics that govern the problem being analyzed. Only after the principles of physics have been identified will the mathematical formulation and solution technique be addressed. The intent is to identify the mathematical formulation and solution technique in a generic manner. This approach is intended to encourage a pedagogy of classifying the mathematical models and solution techniques required to solve engineering problems in a generic manner. This sequence emphasizes the principles of physics first and the mathematical details second. In addition, by attempting to classify the mathematical models generically rather than in a problem-specific manner, a problem solution technique (PST) may be illustrated that may make it more comfortable for engineers to use applied mathematics that have, perhaps, been developed or refined in fields other than that of their own training and education.

This pedagogy will hopefully make it possible for engineers to be more comfortable with applied mathematics from a wide variety of different technical fields. In an effort to illustrate the value of this approach, a rather brief selection of the limited mathematics applied in this review is assembled in Chapter 2 in a generic manner. This illustrates the approach by referring to this collection repeatedly throughout the review when the mathematical models are required, rather than to a specific problem where a particular mathematical model or solution technique is first encountered. It will also have the advantage of not imbedding in isolated sections important mathematical operations or functions that are applied repeatedly; and then forcing the reader to search out at some later time the desired mathematics by referring to another engineering topic instead of to the appropriate generic mathematical model. This approach will hopefully avoid giving the false impression that the mathematics are problem-specific; an impression that is not at all related to the way that mathematical models are employed in real engineering applications.

This particular pedagogy may facilitate the ability of engineers to apply mathematical techniques that may have been developed or refined in technical fields other than their own. An obvious impediment to engineers extracting mathematical techniques from other technical fields is that engineers have been trained to approach problems from a basic understanding of the governing principles of physics. Grazing through journals or references in other technical fields looking for mathematical techniques that may be applicable to an engineering problem at hand may, at first, be uncomfortable because of a lack of understanding of the principles of physics applied in the foreign technical field. However, because the mathematical techniques are not related uniquely to any unique principle of physics, but are rather more generic; it then makes sense to look for generic mathematical techniques in these foreign technical fields even though the principles of physics in that particular foreign technical field may not be well-understood.

The first step required to compute the magnitudes of the wave-induced loads on a structure is to estimate the effect of the structure on the wave field. The two extreme examples of this effect of wave-structure interaction are described by two separate theories: 1) small body or Froude–Kriloff theory; and 2) large body or diffraction theory. The distinction between wave loads on large and small structures depends on both the wave steepness parameter kA and the Stokes parameter $\boldsymbol{S} = (kA)/(kh)^3$ (Stokes, 1849). The distinction between wave loads on large and small structures may be observed physically; viz. 1) what may be observed, and 2) what may not be observed.

In the small body or Froude-Kriloff theory, a relatively small structural member is assumed to have no sensible effect on the wave field and waves propagating past the structure remain essentially unmodified by the presence of the structure. Physically, flow separation around the body and the formation of a wake behind the member may be observed due to the effects of the fluid viscosity; while no waves will be observed radiating away from the structure. The Morison equation is applied to compute these loads from a deterministic wave theory in Chapter 7.

In the large body theory, a relatively large structural member will exhibit a significant and noticeable effect on the incident wave field; and a *scattered* (from a fixed body) and a *radiated* (from a freely floating body) wave may be observed. Potential theory is applied to compute the loads from a deterministic wave theory on large bodies in Chapter 8.

Finally, loads on both small and large structures computed from random wave theory are reviewed in Chapter 9.