CHAPTER 18

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ANALYSIS AND DESIGN OF SHIP STRUCTURE

18.1 GENERAL NOMENCLATURE

For specific symbols, refer to the definitions contained in the various sections.

ABS American Bureau of Shipping
BEM Boundary Element Method
BV Bureau Veritas
DNV Det Norske Veritas
FEA Finite Element Analysis
FEM Finite Element Method
IACS International Association of Classification Societies
ISSC International Ship & Offshore Structures Congress,
ISOPE International Offshore and Polar Engineering Conference,
ISUM Idealized Structural Unit method
NKK Nippon Kaiji Kyokai
PRADS Practical Design of Ships and Mobile Units,
RINA Registro Italiano Navale
SSC Ship Structure Committee.

a = acceleration
A = area
B = breadth of the ship
C = wave coefficient (Table 18.I)
C_B = hull block coefficient
D = depth of the ship
g = gravity acceleration
m(x) = longitudinal distribution of mass
I(x) = geometric moment of inertia (beam section x)
L = length of the ship
M(x) = bending moment at section x of a beam
$M_T(x)$= torque moment at section x of a beam
p = pressure
q(x) = resultant of sectional force acting on a beam
T = draught of the ship
V(x) = shear at section x of a beam
$_{S,W}$ (low case)= still water, wave induced component
$_{V,H}$ (low case)= vertical, horizontal component
w(x) = longitudinal distribution of weight
θ = roll angle
ρ = density
ω = angular frequency

18.2 INTRODUCTION

The purpose of this chapter is to present the fundamentals of direct ship structure analysis based on mechanics and strength of materials. Such analysis allows a rationally based design that is practical, efficient, and versatile, and that has already been implemented in a computer program, tested, and proven.

Analysis and *Design* are two words that are very often associated. Sometimes they are used indifferently one for the other even if there are some important differences between performing a design and completing an analysis.

Analysis refers to stress and strength assessment of the structure. Analysis requires information on loads and needs an initial structural scantling design. Output of the structural analysis is the structural response defined in terms of stresses, deflections and strength. Then, the estimated response is compared to the design criteria. Results of this comparison as well as the objective functions (weight, cost, etc.) will show if updated (improved) scantlings are required.

Design for structure, refers to the process followed to select the initial structural scantlings and to update these scantlings from the early design stage (bidding) to the detailed design stage (construction). To perform analysis, initial design is needed and analysis is required to design. This explains why design and analysis are intimately linked, but are absolutely different. Of course design also relates to topology and layout definition.

The organization and framework of this chapter are based on the previous edition of the *Ship Design and Construction* (1) and on the Chapter IV of *Principles of Naval Architecture* (2). Standard materials such as beam model, twisting, shear lag, etc. that are still valid in 2002 are partly duplicated from these 2 books. Other major references used to write this chapter are *Ship Structural Design* (3) also published by SNAME and the *DNV 99-0394 Technical Report* (4).

The present chapter is intimately linked with Chapter 11 - Parametric Design, Chapter 17 - Structural Components and with Chapter 19 - Reliability-Based Structural Design. References to these chapters will be made in order to avoid duplications. In addition, as Chapter 8 deals with classification societies, the present chapter will mainly focus on the direct analysis methods available to

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