Chapter 9
Compounding of Stresses in Ship Strength Members

1 Introduction

This chapter gives a full analysis of the compounding of stresses induced in the various ship strength members of transversely and longitudinally stiffened double bottom and deck structures. The compounding of stresses is carried out for the main ship strength members which includes girders, longitudinals and plating. The compounding of stresses induced in any strength member takes account of the primary, secondary and tertiary stresses. Depending on the location of the strength member in the ship structure, the primary stresses included in the compounding process of stresses are calculated when the ship is in sagging or hogging conditions. The compounding of stresses in tank top longitudinals and plating are also considered. The compounding of stresses of bottom plating takes account of the local stresses induced by the local loading of the external water pressure. The compounding of stresses are carried out at the locations expected to reveal the highest values of compound stresses. The strength members considered for the compounding process includes girders, longitudinals and plating in bottom and deck structures.

2 Various Stresses in Strength Members of Ship Structure

All strength members of ship structure are subjected to several types of stresses induced by external and internal loads, see Fig. (9.1). The fabrication of ship structural members by gas cutting, forming, welding and assembly work induce complicated systems of residual stresses. These residual stresses do not appear in the structural members as they are in equilibrium internally. The hull girder of a ship is subjected to longitudinal vertical and horizontal bending moments, shear forces and torsional moments. These hull girder loadings induce stresses referred to as primary stresses in the primary strength members. Strength members of ship structure assemblies are subjected to cargo and external water pressure loadings which induce stresses called secondary stresses. Tertiary strength members are subjected to tertiary loadings which induce a third type of stresses called tertiary
stresses. The bottom plating is subjected to additional local loadings exerted by the external hydrostatic water pressure. These local loadings cause bending of bottom plate panels and thus induce local bending stresses.

The compounding of these stresses for some strength members could reach unacceptable high values of equivalent stresses which may exceed the allowable stresses of the material and cause structural failure.

Under certain conditions, the ship hull girder is subjected to other types of loadings and stresses. The main causes of these stresses are the presence of thermal gradients, launching of ship, occurrence of accidents such as grounding, collision, etc.

**Fig. 9.1** Various types of stresses in ship structure

**2.1 Total Stress Induced in Ship Structural Members**

The total stress at any point on the ship hull girder is composed of one or more of the following categories of stresses:

- Primary stresses: hull girder stresses
- Secondary stresses: induced in secondary structures
- Local stresses: induced by cargo + local pressures
- Fabrication stresses: residual stresses (Cutting, forming, welding and assembly work)