BUCKLING AND ULTIMATE STRENGTH OF SHIP AND SHIP-LIKE FLOATING STRUCTURES

Tetsuya Yao and Masahiko Fujikubo

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Preface

It was more than 50 years ago that Timoshenko and Gere published a book titled *Theory of Elastic Stability*. This book fundamentally deals with elastic buckling and postbuckling behavior, and is even at present a good textbook for those who study buckling. On the other hand, problems related to plasticity had been also hot topics in the mid-20th century and many papers were published. However, they were fundamentally based on analytical formulations and were difficult to be applied to practical problems. It was after the 1970s—ie, since the numerical method called finite element method has been developed and performance of computer has been significantly improved—that practical problems related to plasticity have been solved.

The breaking of the structural member in tension was the design criterion for the structure in the 19th century. Then, yielding was introduced as a design criterion, and then in the early 20th century, buckling was also introduced as a criterion. After that, fatigue is considered as one of the design criteria. Now, the ultimate strength is considered as the newest design criterion for ship structures.

On the other hand, although good textbooks have been published relating to "Mathematical Theory of Elasticity," only a few related to buckling/plastic collapse behavior and ultimate strength. From this point of view, we decided to write a new textbook describing in detail what buckling/plastic collapse behavior is and the ultimate strength in ship and ship-like floating structures. As for the external loads acting on ships, description is only given in Chapter 8, where a new integrated motion/collapse analysis system is introduced to simulate the progressive collapse behavior of a ship hull girder in extreme waves. The readers who are interested in the load analyses are recommended to refer to other appropriate textbooks.

This textbook aims at providing better understanding of buckling/plastic collapse behavior of structural members and systems, and derivations of equations are made as concisely as possible. The derivation of some equations is left for readers as exercises, which will be helpful for realizing the essence of the theory.

In Appendix A, a chronological table is given as for research works and events related to buckling. Social events are also indicated in this table. In Appendix B, a brief explanation is made as for the new idealized structural unit method (ISUM) plate element. In Appendix C, structural characteristics and the strength issues to be considered are explained for representative types of ships.

The readers of this textbook are expected to have general knowledge about "strength of materials." In the title, the readers can find "ship and ship-like floating structures." However, the contents up to Chapter 7 are quite general, and are essential not only in the fields of naval architecture and ocean engineering, but also in mechanical engineering and architecture as well as civil engineering. The readers could be graduate students and young engineers who are studying in the field dealing with mainly steel structures.

Tetsuya Yao and Masahiko Fujikubo
May, 2016

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The authors are grateful to Prof. Ueda, who was their supervisor when they started their research carriers. To learn the way of thinking and the attitude for research activity has been very helpful for the authors to carry out research works.

At the end, the authors greatly thank their wives, Mikiko Yao and Keiko Fujikubo, for their patience to let the authors concentrate on research works and for their help in daily life for a long time.

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