



# Study on Risk of Ship Collision in Bridge Life-cycle Based on Synergetic Theory

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## Abstract

The study on the risk of ship-bridge collision has always been a significant subject in academic research. However, the study of ship-bridge collision risk is rarely mentioned from the perspective of the bridge life-cycle. This paper proposes the concept of "bridge-ship common safety" based on the synergetic theory and constructs a high-level cooperative platform to solve the problem of bridge-ship collision. It was given in this article by analyzing the interaction relationship among subsystems of environment, ship, and bridge. In this paper, it proposed the analysis method of the ship-bridge collision risk based on synergetic theory with order parameters, including ship-bridge collision probability and collapse probability of bridge. Finally, the Lanjiang Xiangnv Bridge project as the case study is demonstrated. The risk of bridges is evaluated by utilizing order parameters and synergetic degrees. The result shows that the model can reflect the risk of ship-bridge collision properly, which achieves great scientific significance and academic value for enriching the theory in bridge-ship collision avoidance and implementing the concept of "bridge-ship common safety".

**Keywords:** ship-bridge collision; synergetic theory; bridge life-cycle; order parameters; risk.

## 1 Introduction

### 1.1 Research Background

The Ministry of Transport's newly issued "Outline of Inland Waterway Shipping Development" which guides that we will basically build a modern and powerful inland waterway shipping system by 2035. According to incomplete statistics, by 2020, there will be about 2,600 bridges across the "two horizontal and one vertical, two networks and eighteen lines" of inland waterways in China, including the Qiongzhou Strait Project, the Yangtze River Estuary Crossing Project and the Pearl River Estuary Lingdingyang Project. Chinese President Xi Jinping pointed out that a modern and powerful country must possess a strong shipping industry.

Although bridges have brought rapid development dividends to coastal transport and the economy, they have produced to some extent restricted water transport and brought certain safety risks to navigable ships and bridges themselves. The occurrence of ship collision has limited the development of China's shipping industry

In order to investigate and manage the safety hazards of ship-bridges collisions comprehensively, the General Office of the Ministry of Transport and the Comprehensive Department of the State Railway Bureau issued the "Three-year Action Plan for the Implementation of the Management of Hidden Hazards of Ship Collisions on Bridges" to focus on the risk of ship collisions on bridges. This action has alleviated the current safety hazards partly, but it has cost a lot of financial resources. As