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Evaluation on anti-collision performance of multi-level bumper type anti-collision device

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1 Abstract

An innovative Multi-level bumper and energy-consuming system (MBES) with corrosion-resistant steel floating caisson is proposed as protective structures for bridge piers against ship collision in this paper. MBES is provided with a three-level anti-collision module which consists of a corrugated-type energy-absorbing base, rubber fender, corrosion-resistant steel box filled with pre-compressed rubber tire. MBES is assembled in segments, exhibiting good energy absorbing and highly designable properties. This paper aims to evaluate the effectiveness of MBES adopted in a continuous beam bridge using finite element models. Based on the numerical model, the oblique collision situation at different positions were studied. Numerical results indicate the obvious advantages of the device by comparing peak impact force and impact duration. Significantly decrement of the peak impact force and effectively prolonged impact process indicate the superior performance of the device. Multi-level anti-collision fortification, the modular fabrication and replacement, simple maintenance, strong self-floating ability and excellent corrosion resistance make MBES very effective as a bridge protection structure in ship collision.

Keywords: Multi-level bumper; Protective structures; Ship-bridge collision; Numerical Simulation; Impact force.

2 Introduction

Ship collision with bridge can cause a catastrophic event and are occurring at an alarming rate. Such events can lead to the collapse of the bridge, causing deaths, shutting down a primary route of transportation, and costing millions of dollars in repairs[1, 2]. In China, growing traffic requirements result in the increase in the construction of major bridges across large expanses of water, there were also many ship-bridge collisions occurred in recent years[3]. Therefore, how to reduce the damage caused by the ship-bridge collision and to reduce the probability of accidents has led to substantial scientific investigations in the past decade. And it is a direct and effective way to arrange the anti-collision device around the bridge piers and cap. Over the past two decades, various types of Anti-collision device have been developed based on the basic principles of energy absorption and momentum buffering, such as fender systems, pile-supported systems, dolphin protection systems, island protection systems, and floating protection systems[1]. Svensson[4] outlined several protective structures designed for 18 bridge piers against ship collision. For a bridge located on the substantial water level variations, a floating energy-absorbing anti-collision device automatically rises as the water level changes is a preferred solution. With increasing use of this floating steel protection system, three major drawbacks have become apparent:(1) a direct contact between the steel pontoon and the pier causes damage to the pier; (2) the steel fender system is not designed in modules, and may not be partially replaced when its components are damaged during a collision; (3) its

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