



## Rehabilitation and Simulation of Movable Bridge

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## Summary

Jiefang Bridge, the only rolling lift bascule bridge existing in China, was built in 1927. This paper presents the research of the rehabilitation design as well as the rolling operation restoration of this movable bridge. After structure inspection and evaluation, it is determined to begin with that numbers of severely corroded members must be replaced, the deck system retrofitted, and the rolling function restored in order to remain the original appearance of the bridge. Then, in order to accurately assess the mechanical performance of movable bridge, the kinematical simulation of the bascule span, during operation under multiple loading conditions and combinations including vehicle load, wind load, and inertial force is carefully studied based on a 3-D FE model. As the result of the research, the rehabilitation design is optimized, counterweight improved, and operation velocity and acceleration proposed. Presently, the rehabilitation of Jiefang Bridge has been finished and rolling operation successfully restored. Subsequent field testing and monitoring have proved that the theoretical analysis of the bridge is valid.

**Keywords:** Scherzer rolling lift bascule bridge, structure evaluation, rehabilitation design, rolling simulation.

## 1. Introduction

Movable bridges, commonly built between later 19th and early 20th century, are usually categorized into four types: retractable bridge, swing bridge, bascule bridge, and vertical lift bridge<sup>[1]</sup>. Today there are still hundreds of movable bridges existing mainly in Europe and America.

Chinese movable bridges are mainly located on Haiho River in Tianjin. Jiefang Bridge, formerly called the New International Bridge, is the only rolling lift bascule bridge existing in China. This bridge, designed by the Scherzer Rolling Lift Bridge Co. of the United States, has been in service for about seventy years. As a historical landmark in Tianjin, the bridge serves as an important junction connecting Tianjin urban areas and the railway terminal, facilitating the shipping business on Haiho River.

However, the carrying capacity of the bridge was partly dissipated over years of environmental intrusion and the bridge was in fact used for thirty years as a fixed bridge. Recent years has found fast economic development along Haiho River, creating a unique urban cultural waterfront landscape with varieties of yachts sailing in the river. The historical Jiefang Bridge has become a scenic sight at Haiho River. But there was not enough span clearance for boats to pass under the bridge. In order to preserve the grace of old bridge and ensure passages of yachts as well as vehicles, it was decided to conduct a complete rehabilitation to restore the rolling function of the bridge. This paper is a case study of the rehabilitation of Jiefang Bridge, concerning bridge inspection and evaluation, mechanical analysis of rolling simulation, re-operation feasibility, structural optimization and rational rehabilitation design.