Proposal for cable replacement method incorporating arch structure in aging cable-stayed bridges

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Abstract

This study introduces an innovative cable replacement method to address corrosion on an aged cable-stayed bridge with an added arch structure. Through cable influence line analysis, strategies were explored to minimize structural impact during replacement in side spans and central span. As a result, it has been confirmed that the allowable stress of the cables at the crane installation position is within acceptable limits for all cases, and even in the most the highest stress is reduced to about 90 percent. Additionally, strengthening replaced cables or using auxiliary cables during outer cable replacement offer potential for a complete cable replacement. The study also examines the process of erecting an arch rib over the sea, providing a solution for mitigating tension in corroded or broken cables. The proposed cable replacement procedure suggests processes for removal and installation, potentially extending the lifespan of deteriorated cable-stayed bridges.

Keywords: cable-supported bridges; corrosion; breakage; reconstruction method; cable-stayed arch bridges.

1 Introduction

In Japan, the aging of established social infrastructure is rapidly progressing. According to the forecast of infrastructure aging by the Ministry of Land, Infrastructure, Transport and Tourism from 2018 to 2033, the percentage of facilities among the 720,000 road bridges exceeding 50 years since construction is expected to increase from approximately 25% to about 63% [1]. The lifespan of bridges varies based on structure, materials, and environmental factors, generally around 50 years. Consequently, contemplating the replacement of approximately 40% of the bridges is imperative, requiring substantial investments in time, funds, and human resources.

Cable-supported bridges such as cable-stayed bridges and suspension bridges face severe corrosion and breakage issues in their cables, with reported collapse incidents [2,3,4]. The cable dehumidification system [5], a corrosion prevention measure, is applicable only to large bridges, leaving preventive maintenance challenges for small to medium-sized suspension bridges unresolved.

To address these challenges, previous study proposes a solution by combining arch structures with aging cable-stayed bridges to enhance longevity and facilitate maintenance. The introduction of arch structures to aging cable-stayed bridges significantly reduces axial forces, bending moments on the main girder, tension in the cables, and bridge deflection under basic design loads. Furthermore, the inclusion of arch structures triples the ultimate strength compared to the original cable-stayed bridge. The aesthetic

https://doi.org/10.2749/manchester.2024.0148
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