Ultimate strength and fatigue life of cable-stayed bridges considering cable corrosion

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Abstract

Cable corrosion significantly decreases the ultimate and fatigue strength of cable-stayed bridges. It might lead to lose the cables and may affect to the entire bridge significantly. In this paper, parametric studies with three different span lengths, different corrosion levels and loss of different cables were performed. Whereas the ultimate strength lowered by about 25% as the cross-sectional area decreased due to corrosion. The elongation also decreases due to corrosion. The ultimate strength was found to sharply drop when the elongation became 1.0%. The fatigue strength of stays was studied taking a 500kN heavy lorry as the representative load. The fatigue strength sharply lowers as corrosion progresses and the severely corrode anchor cable becomes less than 4% of the healthy one. The anchor cables showed the most significant effect to the entire bridges.

Keywords: cable corrosion, ultimate strength, fatigue, cable-stayed bridge, loss of cables

1 Introduction

Cables are one of the most important structural elements that could be defined as a lifeline in suspension type bridges such as suspension bridges, cable-stayed bridges, and arch bridges. In recent years, many cases of cable corrosion have been reported [1-4]. As a result of cable corrosion, the yield strength of the entire bridge was decreased, and some bridges were collapsed. The collapse of Taiwan's Nanfang'ao Bridge in October 2019 is a typical example of the danger of cable corrosion leading to the bridge collapse [1,2]. This bridge was a lower arch bridge, and the main girder and arch ribs collapsed after the cable near the centre broke. Although, the cause of this bridge collapse had been investigated, the main cause of the collapse has not been completely clarified. It was confirmed that some of cables were corroded, which could be considered to be one of the reasons of the collapse. Cable corrosion would lead not only decreasing the cross-sectional area, but also decreasing of the strength, ultimate stress, and fatigue strength. Therefore, it is presumed that the bridge collapse occurred by cable corrosion and fatigue fracture by repeated stress of traffic.

In this study, the effect of cable corrosion on the ultimate strength of the entire cable-stayed bridges is investigated. The cable-stayed bridges have many different designs thus it should be considered as parameters such as span lengths, shapes and materials of main girders and main towers, number of cables and tensioning methods. In order to examine these, the parametric study is conducted which assuming three steel cable-stayed bridges with different span lengths.

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