Load Sharing System Performance Considering Structural Members Contribution in Plate Girder Bridges with Corrosion Damages

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Abstract

Bridges are composed by many structural members, such as girders, deck slabs, cross-frames, etc., which interact each other to resist various load combinations. In the traditional bridge design method, the structural member is usually analyzed as an independent part/member without considering the structural system behavior.

In present study, a whole-scale FE analysis has been conducted for a steel I-girder bridge system with corrosion damages, considering the behavior of the bridge as a system by removing its structural members one by one. It is found from the analytical results that the deck slab and cross-frames are effective for load sharing when corrosion occurs at the girder end of the outer girder subjected to vertical load. As the damage increases, reduction of the maximum load when the deck slab is removed is larger than that of the cross-frames removal. We have also confirmed that the deck slab and cross-frames work as alternative load sharing paths to each other.

Keywords: steel I-girder bridge, bridge system, load sharing, corrosion ratio.

1 Introduction

The huge stock of road bridges constructed during the period of rapid economic growth in Japan is aging rapidly. It is predicted that the number of 50-year-old bridges in the Japanese stock will exceed 50% by around 2029, and in recent years, accidents due to damages that might have led to serious accidents have occurred. The main causes of deterioration of aging steel bridges are corrosion and fatigue, and it has been reported that about half of the steel bridges replaced due to damages in the superstructure had damages originated from corrosion. In addition, in steel I-girder bridges, most of the corrosion were found at the girder ends of the main girders [1]. Since the cross-sectional area of the members decreases with deterioration and damages caused by corrosion, the load carrying capacity of the structure decreases. Although components of a bridge do not behave independently but interrelate with each other as a bridge system (hereafter called bridge system behavior), in the current design method, the members are often treated individually.

On the other hand, there have been studies on the load carrying capacity and redundancy considering the bridge system behaviour [2]. However,