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Analytical study on evaluation of residual strength for steel-concrete composite girder bridge after fire

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Abstract

Fire damage to bridges occurs frequently in Japan and in other countries. Previous bridge fire accidents suggest that it is important to understand the structural performance of the bridges after their exposure to fire. The authors have studied the evaluation of the stress of the steel-concrete composite girder bridges as a simply supported bridge damaged by fire. First of all, fire test was carried out to clarify the temperature distribution of the composite girder and a static loading tests before and after fire were conducted to confirm the effect of the reduction of rigidity from fire. Next, numerical analysis was carried out to indicate the stress distribution and deflection on the composite girder bridge from live load after fire.

Keywords: fire; steel-concrete composite girder; residual strength; rating factor.

1 Introduction

The frequency of bridge damage, such as from misfiring during repainting and fires from tank lorry vehicle overturning during accidents, has increased in Japan and in other countries [1]. Misfires are a frequent occurrence with maximum temperature reaching at approximately 700°C. On the other hand, fuel fires are an infrequent occurrence with maximum temperature reached being at over 1000°C. There is a danger of bridge collapse after fire. To the best of the authors' knowledge, no bridge collapses have been reported in Japan.

Figure 1 illustrates general flow from bridge fire occurrence to restoration. This figure shows that the relationship between temperature and time. The load conditions DL and LL denote dead load and live load. Also, the status shows some events from fire occurrence to investigation. We defined "after fire", that is the temperature of the bridge becomes room temperature after extinguishing.

The Japan Society of Civil Engineering (JSCE) has proposed guidelines for the diagnosis and repair of the steel bridges that have been exposed to fire [2]. This guideline provides a judgement temperature of the steel members of 400°C. Another technical report [3] published by JSCE has decided allowable fire temperature of the steel members from 250 to 350°C. However, these temperatures were established based on previous bridge fire reports or material test results. It is unclear if the basis for evaluation has been the structural members.

Experiments and analyses have been executed to establish the behaviour of steel girder during fire in foreign countries [4], [5]. Accordingly, some experiments and analyses are executed for the behaviour of steel girder during fire. For example, Aziz executed experiment and analysis of the behaviour of the steel bridge during fire [4]. Also, Reis simulated of shear buckling in the steel girder during fire [5].

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