Investigation on Extreme Temperature Gradient Action of Composite Girder Bridges Considering Regional Difference

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Abstract

To reach an accurate calculation of the effect of composite girder bridges under extreme temperature gradient action, long-term temperature measurements and finite element simulations were performed on a composite girder segment in Huangnan Prefecture, Qinghai Province for more than one year. By setting the maximum thermal self-stress and secondary stress as indexes and considering different sunshine conditions between interior and exterior girders webs of composite girder bridges, 3 temperature gradient patterns were established for multi-girder bridges. Based on the long-term historical meteorological data collected from 839 weather stations in China, a "layer-by-layer drawing method" was put forward to the isoline map of extreme temperature gradient values. Compared with the current specification, the temperature action values provided are more suitable for the Limit State Design Method.

Keywords: bridge engineering; extreme temperature action; steel-concrete composite girder bridge; regional difference; isoline map.

1 Introduction

Bridge structures are subjected to temperature actions caused by solar radiation, annual temperature variations, daily temperature variations in a complex operating environment. Temperature gradient is one important temperature action generating high thermal stresses, further causing concrete cracking and seriously affecting the operational safety and durability of bridges [1-2]. In recent years, at an average altitude of 5,000 m above sea level, approximately 125 km of the Qinghai-Tibet Highway has been constructed in the form of composite girders [3]. The effects of extreme temperature actions on bridges will be even more severe in these high-solar radiation areas.

Early scholars usually assumed a vertically linear temperature distribution along the bridge girder. Later scholars have proposed different non-linear temperature gradient patterns for concrete box girders, including the 5 times parabolic pattern firstly proposed by Priestley [4], the double folded pattern of the American AASHTO Code [5] and the

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