Evaluation of a Continuous Rigid Frame Bridge with Early Transverse Cracking

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Summary

Early transverse cracking in the deck segment on interior pier of continuous rigid frame bridge constructed by balanced cantilever method is one of the dominant forms of bridge defects experience. These cracks often initiate soon after the deck segment on interior pier is constructed. Most of the past efforts addressing to transverse cracking have focused on causes and changes over the years in concrete material properties. However, bridge owners are more concerned with the impact of early transverse cracking on the performance and durability of the bridges. Thus bridge owners can make rational decisions vary from doing nothing to total rejection. This paper presents a comprehensive numerical study on a continuous rigid frame bridge with early transverse cracks in the China Western. The crack repair forms, crack numbers as well as crack spatial dimensions are considered as major causes in three 3D solid models with practical data. Analysis results showed that the existence of early transverse cracking in the deck segment on interior pier did not create much weakness in the structural static behavior.

Keywords: early transverse cracking, continuous rigid frame bridge, FEM analysis

1. Introduction

The underlying principle of cracking occurrence is that the tensile stresses exceed the tensile strength of the material. Although the compressive strength of concrete is relatively high, but it has a relatively low tensile strength. So a variety of causes may develop cracks in structural concrete from construction to period of use. The report in ACI 224 [1] and TRB [2] summarized the common types of cracking in concrete, and described main forms of cracks, primary causes and the time of crack appearance. The cracks are distinguished based upon when they appear in concrete, before hardening or after hardening. Cracks that occur after hardening may be caused by a variety of reasons, including mechanical loading, moisture and thermal gradients, chemical reactions of incompatible materials or environmental loading, etc. And among them, moisture and thermal gradients may develop two types of cracking. They are thermal expansion and contraction cracks and drying shrinkage cracks. The form of these two kinds of cracking is transverse. The former may generally appear in the period of 1 day to 2-3 weeks, and the latter may occur weeks to months. They may occur in the construction and be visible soon after the concrete formwork is removed. Such cracks are named early transverse cracking.

Large-span continuous rigid frame bridge is usually constructed by balanced cantilever method. The deck segment on the interior pier is not generally treated as being mass concrete, but it has relative large dimensions. Meanwhile the concrete segment is placed against the casted interior pier that is comparatively rigid material to adhere, then this rigid structure may provide the necessary restraint to cause cracks in the newly placed deck segment. Relatively large dimensions and comparatively rigid restraints may cause thermal stress problems in construction of deck segment on interior pier. Cracks often initiate soon after the deck segment on interior pier is constructed, and they are caused mainly by restrained shrinkage and thermal expansion and contraction of concrete in mass. So early

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