Prestressed SCC Bridge Girders under Monotonic and Fatigue Loading

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Summary

This paper examines the flexural behavior of prestressed self-consolidating concrete (SCC) bridge girders when subjected to monotonic and fatigue loading. Three full-scale prestressed bridge girders were constructed and tested until failure. One of the girders was made with conventional concrete (CC) and served as a control specimen, while the other two girders were made with SCC. The girders were fitted with composite CC thickening over the top flange to represent composite bridge decks. The control girder and one of the SCC girders were subjected to monotonically increasing load until failure. The remaining SCC girder was subjected to a sequence of fatigue loading series with increasing load amplitudes, followed by monotonic loading until failure. The results show that prestressed SCC and CC bridge girders exhibit identical behavior under monotonic loading. The stiffness of the SCC girder decreased with an increase in the upper limit of the load range even prior to flexural cracking. However, the stiffness did not reduce significantly within the same load range.

Key Words: Prestressed Bridge Girders, SCC Girders, Transfer Length, Fatigue, Flexural Stiffness

1. Introduction

In 2009 it was reported that more than one in four bridges in the United States were either structurally deficient or functionally obsolete [1]. The cost of improving the conditions of bridges in the U.S. was estimated at $17 billion annually [1]. The high cost of either replacing or upgrading the deficient bridges prompted engineers to investigate the feasibility of constructing new bridges using innovative materials that possess enhanced engineering properties.

Studies have shown that the use of self-consolidating concrete (SCC) results in improved finished quality, increased production efficiency, and reduced labor cost [2,3]. Because of the favorable properties exhibited by SCC, the Federal Highway Administration and the precast concrete industry have been promoting the research and development of SCC for structural applications in bridges [4].

The hardened properties and performance of SCC is dependent, among other things, on the coarse aggregate physical properties. Quartzite aggregates are widely used in the United States' upper Midwest region. However, due to lack of data on the performance of prestressed SCC in general, and those made with quartzite aggregates in particular, there was hesitancy by regional engineers and producers to design and fabricate prestressed SCC bridge girders.

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