Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 6, No. 1, January, 2020

Application of Large Prestress Strands in Precast/Prestressed Concrete Bridges

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Received 06 October 2019; Accepted 16 December 2019

Abstract

The objective of this research is to investigate the advantage of using large-diameter 0.7-inch (18 mm) strands in pretention applications. Large-diameter strands are advantageous in bridge construction due to the increased girders capacity required to sustain exponential increase in vehicle numbers, sizes, and weights. In this research, flexure capacity of girders fabricated using 0.7-inch (18 mm) diameter strands will be calculated and compared to bridge capacities constructed using smaller strands. Finally, two similar bridge sections will be designed using 0.6-inch (15 mm) and 0.7-inch (18 mm) diameter strands to quantify the structural advantages of increased strand diameter. The research findings showed that a smaller number of girders is required for bridge construction when larger strands are used. Four girders are required to design the bridge panel using high performance concrete and large diameter strands, as compared to 6 girders required when regular concrete mix designs and normal size strands are used. The advantages of large strands and high-performance concrete mixes include expedited construction, reduced project dead loads, and reduced demand for labor and equipment. Thus, large strands can partially contribute to the improvement of bridge conditions, minimize construction cost, and increase construction site safety.

Keywords: Large Prestress Strands; 0.7-inch Strands; Pretention Applications; I-girders; Strands Spacing; High Strength Concrete.

1. Introduction

The percentage of structurally deficient bridges within the United States National Bridge Inventory (NBI) is more than 10%, excluding railroad bridges, according to recent statistics. Structurally deficient bridges include all bridges with severe deterioration in one or more of the bridge structural components (i.e. bridge substructure, girders, and/or deck). Bridge deterioration is enough to reduce the load rating of bridge structural component. Majority of structurally deficient bridges result from increased traffic, the exponential increase of vehicle loading, environmental attacks (i.e. scour, freeze and thaw cycles, etc.), and the use of de-icing salts and chemicals in northern states. The Federal Highway Administration (FHWA) and State Departments of Transportation (DOTs) have recently launched multiple research programs to investigate the possibility of constructing bridges with longer life spans and/or using new generations of construction materials with superior characteristics to minimize maintenance, repair, and replacement activities for different bridge structural elements. New generations of construction materials include reactive powder concrete [1-4], commercially known as ultra-high-performance concrete, fiber reinforced polymers, and large diameter strands.

The main objective of this research project is to investigate the possible use of large-diameter prestressing strands in fabricating bridge I-girders with superior strength and quantify the structural advantages attained when large diameter strands are used in I-girder fabrication. The research project includes two phases: First, an analytical phase to calculate

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http://dx.doi.org/10.28991/cej-2020-03091458