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TESTING OF AN ULTRAHIGH-PERFORMANCE CONCRETE OVERLAY DEVELOPED USING LOCAL MATERIALS

Mark P. MANNING
Doctoral Candidate
New Mexico State University
Las Cruces, USA
mpmann@nmsu.edu

Brad D. WELDON
Associate Professor
New Mexico State University
Las Cruces, USA
bweldon@nmsu.edu

Craig M. NEWTSON
Professor
New Mexico State University
Las Cruces, USA
newtson@nmsu.edu

Contact: mpmann@nmsu.edu

1 Abstract

The superior mechanical and durability properties of ultrahigh-performance concrete (UHPC) offer significant potential advantages when used as an overlay material—a common method for extending the service life of concrete bridge decks. Providing high compressive strength, improved environmental resistance, and increased service-life expectancy compared to conventional concretes, UHPC mixture proportions can be adapted using local materials. Flexural testing of a high-performance concrete (HPC; 66 MPa) prestressed channel beam bridge girder was conducted to investigate the use of nonproprietary UHPC (120 MPa) developed using materials primarily local to New Mexico, USA, for bridge deck overlays. The girder was first subjected to cyclic loading (minimum 1000 load-unload cycles to deflection-based service load conditions) to establish baseline performance and behavior. The girder surface was then textured, and a 25 mm nonproprietary UHPC overlay was cast. Cyclic loading was repeated for the girder-overlay system before loading the system to failure to investigate post-cracking flexural behavior. The UHPC overlay developed satisfactory bond with the HPC substrate without a bonding agent and exhibited no visible signs of distress or debonding after cyclic loading. Comparative analyses indicated increased stiffness and capacity for the girder-overlay system.

Keywords: UHPC; ultrahigh-performance concrete; nonproprietary; overlay; bridge deck; flexural behavior; steel fiber reinforcement.

2 Introduction

Overlays are a common method for extending the service lives of new and existing concrete bridge decks, providing comfortable and safe riding surfaces and protection from mechanical and environmental distress to underlying structural elements. Ultrahigh-performance concrete (UHPC) exhibits several qualities that make it a logical choice for overlay applications. Characterized by high compressive strength (120 MPa or greater), advanced durability properties, increased ductility and post-cracking strength from fiber reinforcement, and longer service-life expectancy, UHPC overlays have been successfully implemented in several countries [1–9]. Moreover, UHPC mixture proportions for overlay applications can be adapted to locally available materials [5,10].

Previous research at New Mexico State University (NMSU) developed nonproprietary UHPC mixture proportions using materials primarily local to New Mexico, USA [10]. These mixtures have been modified and are currently being evaluated and optimized for overlay applications on concrete bridge decks [10,11]. This study investigated the flexural behavior of a full-scale high-performance concrete (HPC; 66 MPa) prestressed bridge girder with a 25 mm overlay using the nonproprietary

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