Precast Spun Concrete Piers of Road Bridges and Their Probability-Based Design

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Summary

The usability of precast spun concrete members of annular cross-sections as pier shafts for road bridges and footbridges is discussed. First and second order load effects for shafts of braced and bracing piers are analysed. The modeling of resisting compressive forces and bending moments of eccentrically loaded spun concrete shafts is considered. The features of mechanical properties of compressed spun concrete specimens reinforced by cold worked high-strength steel bars are presented. A simplified but fairly exact analysis of pier shafts by limit state and probability-based approaches is provided. A design of tubular shafts of braced piers using semi-probabilistic and probabilistic reliability verifications is illustrated by a numerical example.

Keywords: Road bridges; spun concrete piers; high-strength steel; road traffic loads; second order effects; probability-based design.

1. Introduction

Precast spun (centrifugally cast) concrete shafts of annular cross-sections reinforced by steel bars uniformly distributed throughout their perimeters satisfy economical, constructive and aesthetical requirements for road bridges of urbanized areas. Therefore, they may be successfully used in construction practice of piers of valley and overpass road bridges and footbridges. In some cases, it is expedient to use high-strength reinforcing steel bars increasing a bearing capacity of slender shafts exposed to compression with a small bending moment [1].

The recommendations and directions presented in codes and standards for design and detailing rules of concrete structures are not fully formulated. In some cases, it hampers the development of analysis methods of spun concrete structures. Undoubtedly, the analysis of bearing capacity and structural safety of eccentrically loaded spun concrete piers under compression with a bending moment or bending with a compressive force has some characteristic features. Therefore, their design in a simple and easily perceptible manner is desirable by design engineers.

Contemporary design codes for bridge structures prescribe reliability verification methods exposed on limit state concepts. However, the reliability level of spun concrete piers designed by these concepts may differ considerably. The actual reliability level of piers may be defined only by probability-based approaches. However, for practical sake, the methodological and mathematical features of probabilistic approaches should be unsophisticated.

The object of this paper is stimulating of highway and structural engineers to use effective precast spun concrete shafts in bridge engineering and simplified but fairly exact probabilistic approaches in their design practice.

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