Effect of Short-Term Shrinkage on Deck Concrete of a Rail-Cum-Road Composite Truss Bridge

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Abstract

Rail-cum-road truss bridges are rapidly developing, and frequent cracking in freshly poured deck concrete is of great concern. For the performance of such a load-bearing deck, it is necessary to understand its stress status due to short-term shrinkage. Taking a newly-constructed rail-cum-road truss bridge as the case project, this paper, by ANSYS finite element simulation, mainly analyzed the stress distribution in deck concrete under short-term action of shrinkage. Shrinkage of one deck panel and two companion specimens shortly after the concrete pouring was measured through in-situ testing. It was found that the free shrinkage of companion specimens at 40 days is 140~150 micro strains, significantly higher than that indicated by the current code. Under the action of short-term shrinkage, tensile shrinkage stress in the magnitude of 1,5~3,5 MPa is present in the deck, triggering potential cracking, and its effect shall therefore not be neglected.

Keywords: short-term shrinkage; composite bridge deck; rail-cum-road bridge; in-situ testing; finite element simulation.

1 Introduction

The early cracking of concrete bridge decks has recently caused rising attention in the bridge engineering industry. Retzepis in Germany reported extensive cracking on the top surface of a typical slab bridge. The cracks appeared, primarily diagonal and surface located, shortly after concrete compacting and smoothing. The crack width mainly was in the range of 0,1~0,55 mm. However, some cracks reached the width of 1,8 mm or 3 mm in the extremity [1]. Similar damage has been reported in Finland and China [2, 3].

It is speculated that such cracking is caused by short-term shrinkage due to dehydration of the concrete surface [4]. Modern concrete tends to develop strength more rapidly, and so could the shrinkage [5]. In continuous testing of shrinkage strain up to 133 days, Zhang et al. demonstrated that shrinkage develops much more rapidly at an earlier stage of the cement hydration process. The portions of shrinkage taking place during 7 d, 7~21 d, 21~42 d, 42~70 d are 72,5%, 19,7%, 5,3%, 2,5%, respectively, of the total amount of 70 days [6].

Although domestic and abroad researchers have gained tremendous knowledge on long-term drying shrinkage [7], studies on short-term

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