Experimental Investigation of Post-cracked Flexural Behavior for PC Girder Bridges

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Abstract

Extended studies are more and more needed for evaluating the post-cracked flexural behavior of PC (prestressed concrete) bridges where the design concept of eliminating cracks cannot be satisfied. In this paper, an experimental program is provided with six scaled specimens to analyze post-cracked flexural behavior of prestressed concrete girders. Mechanical properties, such as ductility, flexural rigidity and load-bearing capacity, are examined according to grouting, loading types and deflections at midspan. The results reveal that grouting provides better behavior by increasing ductility and crack resistance for PC structures. Load cycles have insignificant influence on cracking, ultimate loads and flexural rigidity of the prestressed concrete beams. However, load cycles may decrease non-prestress reinforcement (NPR) yielding loads by 5-12% and will reduce ductility by decreasing ultimate deflection. Furthermore, empirical equations have been presented and validated for evaluating flexural rigidity and load-bearing capacity for PC beams with cracks.

Keywords: Post-cracked flexural behavior; PC bridges; Flexural rigidity; Loading types; Load-bearing capacity.

1 Introduction

Compared to reinforced concrete elements, the main advantage of PC (Prestressing Concrete) system is the absence of cracks in the concrete at the nominal service loads and therefore better durability will be achieved. However, in some extreme conditions like Wenchuan earthquake in China in 2008, a great number of PC bridges suffered severe cracking and damage from seismic loading but still needed to be opened to traffic for urgent saving of people and properties. On the other hand, hundreds of existing PC bridges in China, many of which were built for even less than 20 years, have exhibited severe cracking and large deflection caused by overloaded trucks and/or underestimated practical traffic flows. All these require cracked PC bridges to be in service for a certain long period, although their crack elimination design concept is failed. So their properties like residual capacity of the cracked PC bridges should be evaluated efficiently and/or rapidly with measurable defects such as crack width and deflection.

Currently, most investigations on deteriorating prestressed concrete bridges have so far been concerned with how to determine the extent of deterioration within the girders. Related codes have given reasonable results of crack opening up to the plasticity of passive reinforcement, but

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