Effects Of Partially Unbonded Tendons on Seismic Behavior of Precast Concrete Bridge Piers

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Summary

Recently, seismic action on infrastructures is one of the major concerns, which causes extreme collapse and huge destruction. An advanced high-performance seismic resisting system for bridge substructure is recommended with adopting precast system technology to obtain particularly earthquake resistance, construction time saving, cost elimination, and environmental impacts. A new design concept of precast bridge columns was suggested. Quasi-static tests and nonlinear finite element analyses were conducted to evaluate seismic response of precast segmental bridge piers. The parametric study considered an initial prestressing force, unbounded length of the tendons at the joints, and details of axial steels. The finite element model is elaborated and utilized to assess the behavior of precast columns under seismic load. Concrete damage plasticity and bilinear model represented the mechanical behavior of concrete, reinforcement, prestressing tendon respectively. Partially unbonded tendons in precast columns provided stable ductile behavior after reaching maximum load capacity of the column.

Keywords: partially unbonded; tendon; seismic behaviour; precast; bridge pier.

1. Introduction

The current construction industry has strongly been interested in prefabricated bridge elements and systems. Prefabrication commonly requires centralization of production, standardization, integration, repetition, and factory production. Due to several reasons of construction practices in sites such as poor site management, damage during delivery of products, over-ordering and rework, it is reported that about 10% of building materials will end up as construction waste [1]. Senaratne et al. [2] presented three categories of sustainability on economic, environmental and social aspect by adopting lean prefabrication. However, there are technical challenges for prefabrication. Prefabricated structural members have connections and needs additional devices to integrate them. 3D engineering and point-cloud based geometry control are utilized to overcome the technical challenges of precast concrete elements [3].

Precast concrete columns have bonded and unbonded systems, according to the required performance. Comparing to the bonded prestressed segmental columns, the unbonded system is advantageous for delaying the yielding of the prestressing tendons because the post-tensioning force was distributed throughout the length of the tendons in the unbonded system [4, 5]. Hewes and Priestly performed the tests on unbonded post-tensioned precast concrete segmental bridge columns under lateral earthquake loading [6]. The precast columns withstood without significant or sudden loss of strength up to 4.0% drift ratio. Inversely, the bonded system generates high strength capacity, but limited deformation capacity [7].

In this research, the partially unbonded posttensioning system is introduced to current precast columns. The partially unbounded system was designed to enhance both the higher initial stiffness of the column and minimize the stiffness degradation after exceeding maximum capacity of the

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