Structural performance of precast segmental composite pier cap

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Summary

Prefabrication technologies are making bridge building safer and less disruptive to the environment and traveling public, making bridge designs more constructible and, improving the quality and durability by shifting work to a more controllable environment. Modular bridge substructures with concrete-filled steel tube (CFT) piers and composite pier caps were suggested to realize accelerated bridge construction. The precast segmental pier cap consists of a composite pier table and precast prestressed segments on the table. The pier table has embedded steel section to mitigate stress concentration by small tubes. Each bridge pier has four or six CFT columns which connect to the pier cap. Shear strength of the pier cap was obtained by extending vertical reinforcing bars from the table to the precast segment. Transverse prestressing was introduced to control tensile stresses by service loadings. Structural performance of the proposed modular system was evaluated by static tests. Limit states of the composite pier cap were satisfied by continuous reinforcing bars and prestressing tendons. Standardized modular substructures can be effectively utilized for the fast replacement or construction of bridges.

Keywords:CFT pier; composite pier cap; precast, transverse prestressing; shear strength; limit state.

1. Introduction

Modular structures are prefabricated structures which are code-compliant, fabricated offsite in a factory-controlled environment then transported to a final construction site where the modules are erected and connected each other to foam a finished structural system. Therefore, design, fabrication and assembly should be previously done by considering typical variation of structural parameters. A primary benefit of modular system is its fast project delivery due to the simultaneous process of fabrication in a factory and site work.

Modular construction is a sustainable technology because it optimizes material usage resulting in less material waste. Off-site construction reduces the time and impact on the surrounding construction site and improves quality of materials. Flexibility and recycling of modules reduces the demand of raw materials and minimizes the amount of energy expended to create a structure. Especially, modular bridge structures are excellent for fast rehabilitation of hazard-damaged bridges [1,2].

Pier caps have been the most widely prefabricated in term of strengthening seismic behaviour, while it can delay flexural plastic hinging. This response is attributed to absence of vertical joint stirrups; which permitted unrestraint development, growth, and widening of joint shear crack [3]. With precast prefabricated pier, the steel ducts provide passive confinement of connector, which was mobilized after the formation of splitting crack in concrete. It resulted in relatively stable bond stress-slip response [4].

Concrete filled tube (CFT) pier column to foundation connections have been proposed by Roeder and Lehman [5] in several categories. For instance, embedded column connection and variations on the steel base plate connection were considered. Regarding to cast-in-place connection of CFT pier to footing, it was a simple and economical connection that permits rapid construction. By Elchalakani*et al.* [6] and Hu *et al.* [7], CFT pier column has been used to improve seismic behaviour such as preventing local buckling and more efficient confinement to the concrete.

In this paper, a new modular bridge pier cap was proposed to use combination of a composite and a

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