An experimental study on the service and ultimate behaviour of post-tensioned composite slabs

Gianluca RANZI
Associate Professor
The University of Sydney
Sydney, Australia
gianluca.ranzi@sydney.edu.au

Safat AL-DEEN
Lecturer
UNSW@ADFA
Canberra, Australia
S.Al-Deen@adfa.edu.au

Brian UY
Professor
Univ. of Western Sydney
Sydney, Australia
b.uy@uws.edu.au

Summary

Post-tensioned composite steel-concrete slabs represent an economical form of construction for flooring systems. These consist of thin-walled profiled steel sheeting, post-tensioning strands, concrete and non-prestressed reinforcement. The particularity of this structural solution relies on the ability of the profiled steel sheeting to act as permanent formwork and, once the concrete has hardened, as external reinforcement. Unlike the case of steel reinforcing bars, which are cast in the concrete, the sheeting does not benefit from being totally embedded in the concrete. For this reason, the structural response significantly depends upon the interaction between the profiled steel sheeting and the concrete. In this context, this paper presents the experimental results of two series of tests carried out on six simply-supported post-tensioned composite samples at both service and ultimate conditions. The samples considered in this study have been cast using Stramit Condeck HP® and Stramit PrimeForm® steel decks. Standard material property tests are carried out on the concrete, steel decking and steel prestressing strands to determine their respective properties. Two analytical models were derived as part of this project to predict the response of the slabs at ultimate and service conditions, respectively. The former one is based on a rigid-plastic analysis and accounts for the partial shear connection behaviour of the composite slab system. The particularity of the long-term model relies on its ability to capture the non-uniform shrinkage profile produced by the lack of moisture egress from the underside of the slab due to the presence of the steel decking. Comparisons between the numerical and experimental results are carried out and briefly discussed. Further comparisons with experimental results are required to properly validate the adequacy of the proposed analytical models.

Keywords: Composite, concrete, post-tensioning, slab, steel deck.

1. Introduction

Post-tensioned concrete floors have been extensively used in Australia in the last few decades for building applications. The contribution of the profiled sheeting, in terms of both stiffness and strength, is usually ignored by structural engineers due to the lack of design models for post-tensioned composite slabs (Fig. 1). Despite this, designers might account for the presence of the steel deck based on their own engineering judgement. An advantage of this form of construction relies on its enhanced stiffness and strength, when compared to conventional composite slabs, due to the presence of the post-tensioning action.

The use of steel decking as formwork for post-tensioned floor this type of application has been proposed only very recently as a replacement for conventional plywood formwork. Despite the popularity of this form of construction, only limited research and experimental data is available in the open literature, mainly focussing on its strength requirements and performance, e.g. [1-7]. Very recently, a design module was included in the popular commercial design software Rapt [8] to enable the design of post-tensioned composite slabs with Fielders' steel deck profiles [9].

This paper presents the results of two series of experiments carried out on full scale simply-supported post-tensioned slabs. In particular, the first series consisted of three ultimate tests to

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