Experimental and Analytical Studies on Performance of Lapped Composite Slabs

by

HO Chi Kin

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Approved by _____

Supervisor: Prof. IU Vai Pan

_____

Date _____

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Address:

Telephone: +853-66876314
Fax: N/A
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University of Macau

Abstract

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Thesis Supervisor: Prof. IU Vai Pan
Department of Civil and environmental Engineering
University of Macau

The strength and behavior of composite slabs are mainly governed by the longitudinal shear connection between profiled steel decking and concrete. The composite slab is an orthotropic plate element that the design resistance of composite slabs especially for the longitudinal shear resistance can`t be derived directly from simple calculation in current code of standards around the world. Up to this moment, the most reliable approach in standards for evaluation and prediction of these parameters is traditional performance tests. However, the present test configuration of slab tests does not reflect the realistic performance of load-carrying capacity and behavior of composite slabs. On the other side, some of unfavorable phenomenon was influenced the strength that seldom occurred on site condition and normal practical usage.

To investigate the actual performance of composite slabs, eighteen simply supported one-span test specimens were prepared with shorter and longer shear spans. Three different configurations of specimens namely, single width slab, double width slab and side lapping slab in one panel width have been adopted in simply supported slabs. The same geometry and grade of re-entrance profiled steel decking without end anchorage were assumed in this study. The test program was prepared in accordance with the requirement of Eurocode 4 which is currently in force in Macau.

In this experimental study, the structural performance of composite slabs such as maximum applied load, displacement, end slips and strain of concrete and profiled steel decking as well as failure mode of the full scale slabs are investigated and presented among three different configurations of test specimens. A comprehensive parametric and results analysis have been carried out to investigate the behavior and performance of composite slabs among the specimens. The test results in ultimate and serviceability limit state have been recorded and studied in this paper. The parameters of mechanical interlock (m) and friction (k) were investigated from the three series of specimens. The longitudinal shear bond resistance between profiled steel decking and concrete was determined by two methods: by m-k and partial shear connection method (PSC). The difference between two methods from all specimens varies from 4.6% to 31.9%. A considerable increase occurs on the resistance of slabs for namely, side lapping slab specimens compared with single width slab specimens or double width slab specimens. On the other side, the dramatic increase on ultimate resistance of 121% and 158% for specimens of double width slab was found compared with the test results of single width specimens. It is shown that the slabs with short shear span have a higher ultimate load resistance and shear bond resistance than that of the composite slabs with longer shear span. The edge web curling in the specimens of single width panel and double width panels occurred in the slabs with short shear span during the experiments. The edge deflection of slabs was greater than the center deflection at mid span section.

These results revealed that the shortcomings in present test configurations that need to consider and improve in future experiment in order to evaluate the actual performance of composite slabs. Based on the test results, a proposed calculation for predicting the ultimate resistance of wide slabs in this paper is in good agreement with the performance test results of full scale specimens.

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Notation

m	Empirical parameters for design shear resistance
k	Empirical factor for design shear resistance
L	Span; length
L_s	Shear span
L_o	Length of overhang
b	Width of slab
A_p	Cross-sectional area of profiled steel decking
d_p	Distance between the centroidal axis of the profiled steel sheeting and the extreme fibre of the composite slab in compression
γ_{vs}	Partial safety factor for the ultimate limit state.
W_t	Measured failure load
f_y	Nominal value of yield strength of profiled steel decking
$V_{1,Rd}$	Design value of the resistance to shear
N_{cf}	Design value Design value of the compressive normal force in the concrete flange with full shear connection
τ_u	Value of longitudinal shear strength of a composite slab determined from testing
η	Degree of shear connection
$\tau_{u,Rd}$	Design value of longitudinal shear strength of a composite slab
$\tau_{u,Rk}$	Characteristic value of longitudinal shear strength of a composite slab
W_{1crack}	The first crack load
W_{1slip}	The first end slip load
W_{2slip}	The first and second end slip load
$W_{0.1mm}$	The load in which end slip is equal to 0.1mm
$W_{L/250}$	The load for a mid-span on or before deflection of $L/250$
$W_{L/50}$	The load for a mid-span on or before deflection of $L/50$
V_t	Support reaction
δ_{wt}	The deflection of mid span at maximum applied load
δ_{max}	The mid span deflection at the end of test

δ_{1crack} The mid span deflection when first crack

δ_{1slip} The mid span deflection when the first slip

S_{max} Maximum slip at slab failure

$D_{1,crack}$ Distributed load on composite slab at first crack

$D_{0.1mm}$ Distributed load on composite slab at or close to 0.1mm end slip

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