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Behavior of Continuous-Span Composite Slab: A Review

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Abstract

The steel decking is usually supplied in two-span lengths and negative reinforcement is provided in the top of the slabs over the mid-support during construction. This makes the composite slab normally continuous. Nevertheless, it is often beneficial for practicing engineers to assume that the slab is simply-supported in ultimate limit states and use linear-elastic analysis. This study focused on investigate the behavior of continuous composite slab.

Keywords: Continuous-Composite-slab, Negative Moment Region, Displacement, moment Capacity.

INTRODUCTION

The composite slab concrete-steel has achieved several structural benefits, including strength, stiffness, and load capacity compared to the equivalent RC slab. In addition, it can reduce the construction cost and time since there is no need for any shuttering system. In these types of slabs, the profile steel sheet supports the self-weight of a cast in-situ reinforced or post-tensioned concrete slab and after the concrete sets acts as external reinforcement. The composite action between the steel decking and the hardened concrete is dependent on the transmission of horizontal shear stresses acting on the interface between the concrete slab and the steel decking. The steel decking is usually supplied in two-span lengths and negative reinforcement is provided in the top of the slabs over the mid-support during construction. This makes the composite slab normally continuous. Nevertheless, it is often beneficial for practicing engineers to assume that the slab is simply-supported in ultimate limit states and use linear-elastic analysis. This study focused on investigate the behavior of continuous composite slab.

Gholamhoseini et al. (2016)[1]

Carried out experimental study of continuous composite slabs reinforced by steel fiber to measure crack width causing from shrinkage and significance loading. Sixteen full scale slab specimens with different types of interface bond between the concrete slab and steel decking and different types and amounts of reinforcement in concrete. All specimens slab was continuous over the intermediate-support and had a roller-support at each end. This study indicted no end-slip happened under the levels of serviceability load showing full-interaction between the steel sheet decking and concrete slab. The failure mode in all slabs was interface slip at the ends. The behavior was ductile according to Eurocode 4[2]. Compared to the slab with plain concrete, the average of deflections at peak load of composite slabs reinforced by steel fiber was 16% higher. Application of steel fibers for crack control became effective for slab with dosage of steel-fiber with 60 kg/m3, which showed a very significant enhancement in control the crack as the maximum width of crack was often reduced by 50%. The performance of crack control was better than that of the wire steel mesh reinforced slabs.

Abas et al. (2013) [3]

Conducted experimental study to investigate the effects of variable steel-fiber amount on the concrete cracking behavior at the hogging moment region, on the redistribution of hogging moment, on the end-slip between the profile steel sheet and concrete, and on the ultimate load-carrying capacity of the slabs, as shown in Figure 1. 8 specimens of continuous composite slab were tested under load up to failure. This study showed that the addition of steel-fibers provides significant advantages in terms of both the ultimate load at which end-slip between the steel decking and concrete and the ultimate point, as well as on condition that acceptable crack control of concrete at the service loads level. Compared to the case of composite slab containing welded steel mesh over the mid-support without steel-fibers, all case of the slabs including steel-fibers had a higher load capacity and higher end-slip. In addition, the deflections at both the ultimate load capacity and the end-slip load were greater for the specimen containing steel-fibers.

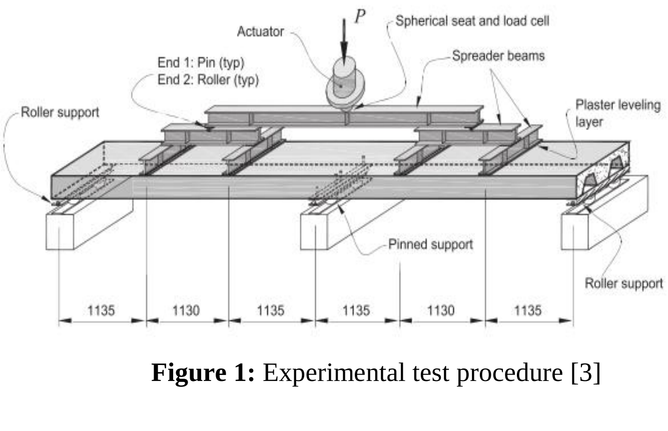

Figure 1: Experimental test procedure [3]

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Leon & Rassati (2013) [4]

Performed experimental test of 3 specimens of continuous composite concrete slabs tested under two point load at each span up to failure. All specimens slab are modelled using a finite element software package (FE) the interface elements contact between the steel decking and concrete slab where modeled. The result showed the maximum flexural capacity of all slabs was controlled by yielding of the reinforcement at the interior support with significant slip at the concrete-steel interface in the shear span, well before the fully plastic moment of the composite cross-section could be reached.

Ackermann & Schnell (2008) [5]

Carried out two different series of experimental test of composite steel concrete slabs reinforced by steel-fiber. The first series test investigated the behavior of rotation capacity of steel-fiber reinforced composite slabs in the negative bending region. In a second test series, 4 specimens of continuous composite slabs tested experimentally. The result demonstrate that reach a good rotation capacity in the negative moment area due to the crack-distribution capacity of the steel-fiber reinforced the continuous composite slabs.

Figure 2: Experimental test [5]

Roberts-Wollmann et al. (2004) [6]

Investigated the effective of different kinds of reinforcement for shrinkage and temperature on and behavior of concrete steel composite slabs with a variety conditions of loading and span arrangements. The tests included three-span composite slabs, with the steel deck continuous over the three spans but with no negative moment reinforcement used, subjected to a uniformly distributed load, and simple span slabs subjected to point and line loads. The performance of the specimens reinforced with fibers is compared with that of the specimens reinforced with WWF. Test results indicate that the strength, failure mode, crack initiation, and propagation, and load–deflection behavior are not greatly influenced by the type of secondary reinforcement in the composite slab. One of the primary issues that remains to be resolved is the relative performance of the secondary reinforcing types in controlling cracking caused by restrained shrinkage and temperature volume changes in the concrete.

Chen (2003) [7]

Investigated the behavior of shear-bond between concrete and profile steel sheet in composite slabs. 7 specimens of simply-supported span composite slabs and two-specimen span of continuous composite slabs were tested. Different end restraints had been used in the simply supported slabs. The specimens' slabs with end anchorage of steel shear stud were found to bear a higher capacity of shear-bond than that of specimens' slabs without end anchorage. The result found that the shear-bond slip model be reasonable to predict the shear-bond resistance of a continuous composite slab. However, the shear span of the continuous composite slabs must be related to the sagging region.

Lee et aal. (2001) [8]

Performed numerical and experimental work to determine the negative moment capacity of typical composite slabs accounting for the contribution of the steel deck and to assess the ductility of such slabs. This study the behavior of steel sheet deck and concrete composite slab under hogging moment. 10 specimens of different slab thickness and reinforcement ratio were performed experimentally. The negative moment capacity of each slab predicted using a simple analytical model was compared with that obtained from the experiment. The experimental results indicate that the steel deck contributes to the hogging moment capacity and this region exhibited a fair amount of ductility, which can be utilized for moment redistribution. The cold-formed steel deck contributes to the negative moment capacity of the composite slabs in relation to the positive moment capacity. The degree of increment in the negative moment capacity is however dependent on many factors. However, it should be noted that the results are significant for cold-formed steel deck with yield strength of 550 MPa and may not be so for steel deck with lower yield strength such as 280 and 350 MPa. The simple analytical model predicts the ultimate negative moment capacity and moment–curvature relation of the composite slabs with reasonable accuracy.

CONCLUSION

The structural behavior of continuous composite slab has been limited studied in the past decades. Experimental and analytical solutions have been conducted and proposed by authors to understand the real behavior of the continuous composite slab. Furthermore, researchers mentioned of the smaller negative moment resistance of the continuous composite slab at the intermediate supports, specifically when limited reinforcement ratio provided at the top of concrete part. Where, they going on improve the hogging moment resistance by added steel fiber to concrete mixture. But, in many cases construction are considered deficient if they are not capable of carrying applied loads. So there rigidity design requirements is an increasing need upgrade by external strengthening the structures for several reasons such as expired design life, change in functionality, potential damage caused by mechanical actions and environmental effects, more, original design and construction errors. However, lack of studies, gap and suggestions were highlighted and discussed as well. No study has been conducted to examine the strengthened of continuous composite slab by CFRP in hogging moment region. Using CFRP laminate to strengthened CPSCS in hogging moment region can be useful to upgrading, thus can increase the hogging moment resistance.

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