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Cast Screws as Shear Anchors for Composite Slabs

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Abstract

Composite slabs consist of trapezoidal steel sheeting and concrete cover. The steel sheeting serves as both, a lost framework and a tension bearing member after hardening of concrete. The longitudinal shear between the sheeting and the concrete must be ensured by a mechanical interlock, for example shear studs or prepressed embossments in the sheeting. The traditional massive shear studs have to be welded to the supporting construction of the slab. Alternatively, thin screws can be drilled through the sheeting and cast into the concrete to ensure the composite action or to strengthen the composite slab in reconstructions locally. The usage of the screws is not limited to the steel supporting frames. This paper describes laboratory tests of the composite slabs with cast screws of various diameters and the effect of the screws on the bending capacity of the slab in combination with prepressed embossments.

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Keywords: Cast screw; composite slab; concrete; embossments; longitudinal shear; shear anchor; steel.

1. Introduction

The global failure mode of composite slab can be bending, longitudinal shear or vertical shear. The longitudinal failure mode is typical for composite slabs. In that case, the shear bearing capacity of the connection between steel sheeting and concrete is crucial to determine the overall bending resistance of the slab. The shear connection can be realized by prepressed embossments in the sheeting. Screws drilled into the sheeting and cast into the concrete can be used as an alternative and local reinforcement of the shear connection.

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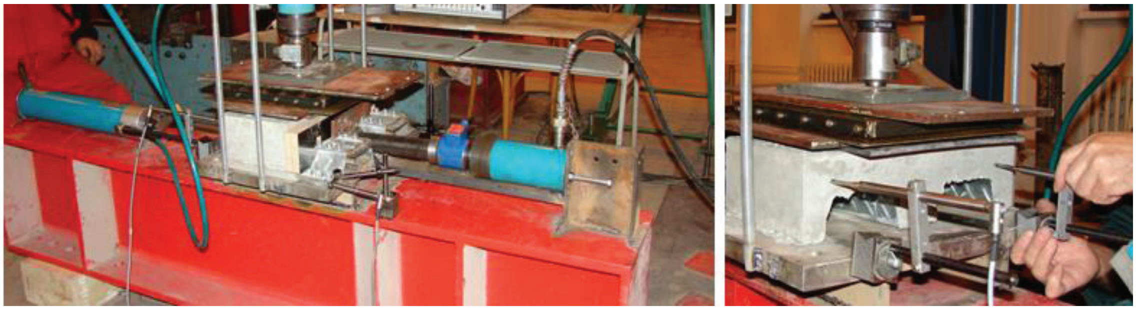
The nowadays codes present two design methods for composite slabs: m-k method and partial connection method. Both methods require bending tests. Alternatively, several design methods using small-scale shear tests have been proposed in scientific literature [1, 2]. Both the bending tests and the shear tests of the slabs with cast screws have been performed. This paper uses the results of the shear test set-up to estimate shear bearing capacity of the screws. The contribution of the screws to the bending resistance of the slab was compared using Built-up bars method [3, 4], Force equilibrium method [5] and using the results of the performed vacuum loading bending tests.

2. Experimental investigation

2.1. Small-scale shear tests

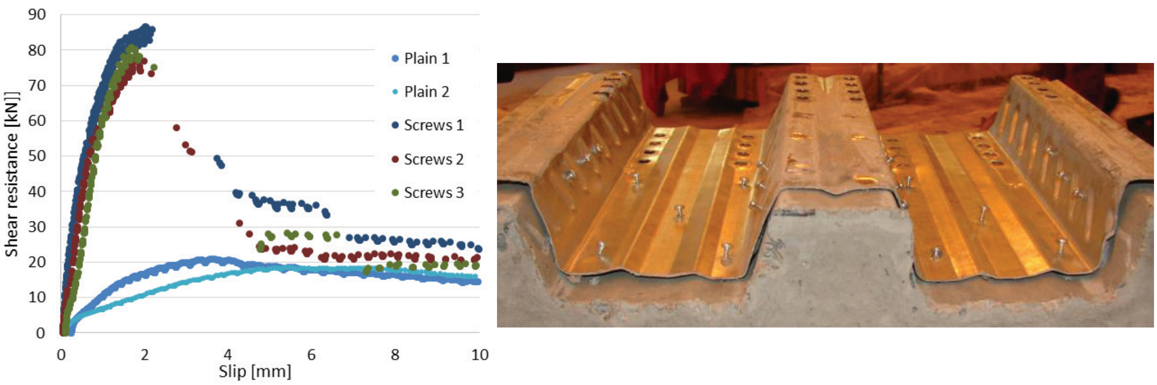
The test arrangement can be seen in Fig. 1. The length of the sheeting of the specimen was 0.33 m, the length of the concrete 0.20 m, width of the specimen was 2 waves (0.41 m) and the thickness 0.11 m. The load was applied by two hydraulic cylinders. The vertical clamping force was transmitted through roller bearing to enable the movement of the concrete block. The concrete block was pushed out of the sheeting by the second cylinder through load distribution plates. The movement of the concrete block and the sheeting and the magnitudes of the forces were measured.



(a) (b)

Fig. 1. (a) Small-scale shear test set-up; (b) concrete block movement measuring devices.

The shear test was performed using Cofraplus 60 sheeting, thickness 1 mm, galvanized surface, material S350GD. The test was performed using plain sheeting as well as sheeting with screws 3.5 x 50 mm which were drilled into the sheeting and cast. Each specimen had 28 screws (Fig. 2). The average concrete compression strength f_c = 61.2 MPa and the average concrete elastic modulus E_c = 31 GPa. The shear bearing capacity of the specimens with screws was on average 65 kN higher than the shear bearing capacity of the plain specimens. The contribution of one screw was then 2.32 kN. The contribution was mainly at small magnitudes of slip (Fig. 2a). After reaching small slip the screws were cut or bent (Fig. 2b) and the shear capacity was decreased suddenly.



(a) (b)

Fig. 2. (a) Comparison of shear resistances of the specimens with screws and without screws; (b) the specimen with screws after the test.