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Timber Floors Strengthened with Concrete

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Summary

Timber-concrete composite (tcc) beams may be used for the renovation of old timber floors. Although these systems are not new (Poštulka, 1997) and form a simple and practical solution, they are not widely adopted. One of the reasons for this is the lack of uniform design rules. In a research programme shear tests on four different fastener types were performed as well as bending tests on tcc beams, manufactured with these fasteners. A non-linear simulation model was built that is able to perform a Monte Carlo simulation on single tcc beams and tcc floor systems. The model was successfully verified with the bending tests before other simulations were performed. Several geometries were simulated resulting in a statistical distribution of the load-carrying capacity of each geometry. This model now allows for the calculation of the characteristic system strength and stiffness values.

1. Introduction

Timber-concrete composite (tcc) floors may be regarded as an alternative renovation method of timber floors in which the timber floor is integrated and thus still functions. Metal fasteners are drilled into the top of the existing timber beams before the concrete is poured upon the planks of the timber floor. After hardening of the concrete a timber-concrete composite (tcc) beam has been realised.

In order to set up design rules for these structures and to obtain the strength and stiffness of some fastener types, a joint research programme was started in 1992. Shear tests on these fastener types and bending tests on tcc beams, in which these connectors were utilised, have been carried out at the University of Karlsruhe in Germany. A simulation model, partly based on the finite element method DIANA, has been developed at TNO and Delft University of Technology that was then used to analyse the beam tests. In this way it was possible to test the validity of the simulation model, to predict the behaviour of other tcc geometries and to obtain the statistical distribution of the short term load-carrying capacities.

2. Shear Tests

The load-displacement curves for four different connector types were determined. These connector types are respectively screws, nailplates and two kinds of dowels. Two of these joint types, screws and one kind of dowel as represented in figure 1, will be discussed here since the other connector types are not suitable for renovation purposes.

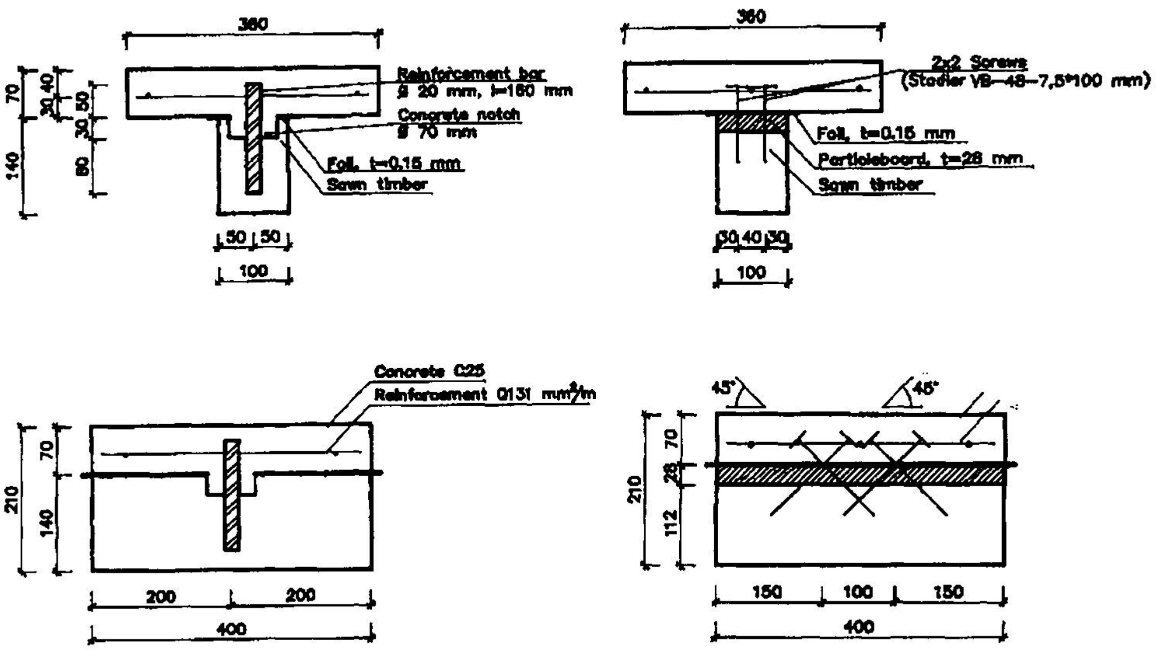

Fig. 1 Two fastener types: reinforcement bar with concrete dowel and screws at 45^0.

The screws are arranged in such a way that half of them is placed at an angle of 45^0 and the other half at an angle of -45^0 with the timber beam axis. The screws are 150 mm long and are driven into the timber for about 100 mm, the remaining part of the screw forms the connection with the concrete. The dowels consist of a reinforcement bar with a diameter of 20 mm and a length of 160 mm, which is driven into the timber for 110 mm. An extra hole with a diameter of 70 mm and a depth of 30 mm surrounds the reinforcement bar and is filled with concrete during moulding. This concrete dowel decreases the stresses in the timber caused by the reinforcement bar.

3. Bending Tests

The bending tests were performed on beams with a span of 5.4 m. These beams were loaded in four-point bending and the slip of several connectors as well as the vertical displacement at midspan was measured. For some connector types the vertical displacement between the timber and the concrete was measured as well midspan and/or near the supports. Due to the type of connector a horizontal gap could occur between the timber and the concrete. Figure 2 shows the test-set-up for the bending tests.