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New concept of composite steel-reinforced concrete floor slab in the light of computational model and experimental research

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Abstract

This paper deals with a new concept of composite steel-reinforced concrete floor slab. This type of the floor slab consists of newly constructed steel and concrete composite beam mandatory connected together with cast in situ or prefabricated floor slab. The description of the nonlinear behavior of this newly designed steel and concrete composite beam with horizontal studs is a subject of a separate paper. Existing test results indicate that the loss of capacity of such structures may be linked to the loss of bonds between the composite beam and the floor slab. To prevent such behavior, special connecting elements have been designed in form of RC studs. Two types of structures, each consisting of composite beam and the prefabricated floor slabs, have been the subject of full scale tests performed in cooperation with ITB strength tests laboratory. Prefabricated prestressed hollow-core floor slabs have been supported on lower flanges of the steel part of the composite beam with reversed TT cross-section to provide a flat lower surface of finished floor slab. In order to prevent the separation of composite beam and floor slabs a number of reinforced concrete studs were arranged for ensuring the adequate bond between these components. The studs have been devised as the set of horizontal rebars passing through the perforated webs of the beam and anchored in the circular openings of the hollow-core slabs. Self-compacting concrete have been used to obtain adequate filling of hollow-core slabs openings. The studs have been designed according to the provisions of Eurocode 2. The expression defining the load carrying capacity of this junction, after some rearrangements, enabled the derivation of equations for the determination of the slab width interacting effectively with composite beam. As an interconnection between composite beam and slabs, these studs have sufficient strength and stiffness to enable both components of the structure to be designed as the parts of a single structural member able to attain the ultimate limit states. During the tests no signs of splitting between beam and slabs subjected to design loads were observed. Experimental and computational results showed satisfactory consistence.

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1. Introduction

This paper deals with a new concept of composite steel-reinforced concrete floor slab. The experience of recent years in the field of prefabrication makes it possible to create a very effective and cost-efficient systems developed as the tailor-made. These include, among others, the floor systems: *slim floor* or *shallow floor* type, i.e. the flush floor slab systems with a low overall height and integrating all elements constructing the floor structures. This is achieved by using asymmetric steel-reinforced concrete composite beams with a properly wide bottom flange, which enables the slabs to be placed on the upper surface of the bottom flange with adequate bearing. The floor slab may be in the form of a precast concrete slab or a composite slab with metal decking (either shallow or deep decking may be used). The main elements of the *slim floor* system are prefabricated slabs, eg. HC type (hollow-core) or semi-prefabricated floor plates with Filigree Slabs or composite plates on trapezoidal sheets - eg. Cofra type, which are supplemented with cast concrete until after the assemble on the site. Supporting elements of the plates, ie. the beams are arranged in the same level with the plates which allows to achieve significant material savings by minimizing the necessary amount of building construction depth.

Existing test results indicate that the loss of capacity of such structures may be linked to the loss of bonds between the composite beam and the floor slabs. To prevent such a behaviour some special connecting elements have been designed in form of RC studs. Experimental and computational results showed satisfactory consistence proving that proposed analytical model provides good results.

2. Structural concept

The considered type of the floor slab - beam structural system consists of newly constructed steel and concrete composite beam mandatory connected together with cast in situ or prefabricated floor slabs. Prefabricated prestressed hollow-core floor slabs have been supported on lower flanges of the steel part of the composite beam with reversed TT cross-section to provide a flat lower surface of finished floor slab (see Figs. 1 and 2). In order to prevent the separation of composite beam and floor slabs a number of reinforced concrete studs were arranged for ensuring the adequate bond between these components. The studs have been devised as the set of horizontal rebars passing through the perforated webs of the beam and anchored in the circular openings of the hollow-core slabs (see Fig. 2). Self-compacting concrete have been used to obtain adequate filling of hollow-core slabs' openings.

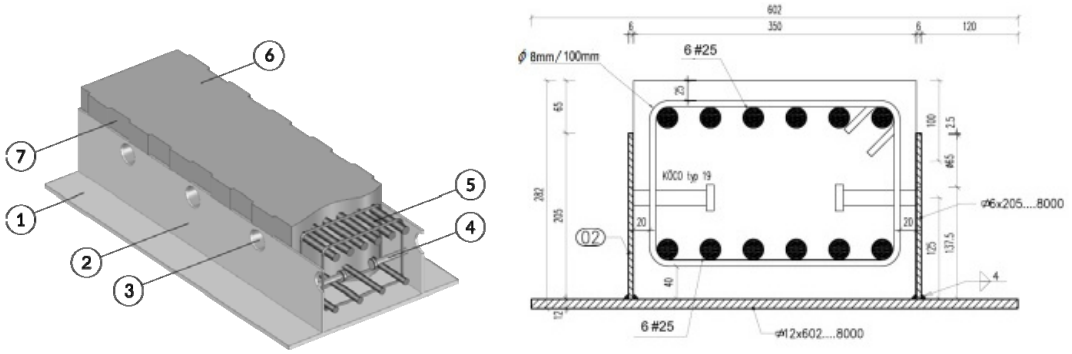

Fig. 1. The rectangular RC cross-section placed inside a reversed TT cross-section steel beam cross-section. Symbols: 1 - the lower flange, 2 – the web, 3 - opening in the beam, 4 - swollen pin, 5 - rebar, 6 – concrete of the beam, 7 - notched surface.