Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 999 (1997)

Artikel: Design and tests of new steel-concrete slabs
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DOI: https://doi.org/10.5169/seals-1088

Design and Tests of New Steel-Concrete Slabs

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Summary

Results of analysis and full-scale tests of new deck and roof slabs, designed as composite steel-concrete structures are presented. The new system of anchors was used for connetion of steel load-bearing profiled sections and concrete, filled in their. Shear bond resistance of the anchor connectors and strength of the slabs were researched with tests.

1.Composite deck -slab

New structure of composite steel-concrete deck slab was worked out with CNIIPSK(Moscow) and EXERGIA Co (Lipetsk). The slab is consisted of profiled steel sections like cassettes, manufactured from galvanised steel sheet of thickness from 0,8 to 1,2 mm with cold-forming. Depth of section's wall -300 mm, flange width-110 mm, length-up to 13 m. Sections are supported with their walls on deck beams and connected each other with edge folds of flanges using seaming machine. The sections are fixed to beams with screws, nails or welded studs. The sheeting of sections is used as permanent shuttering and work reinforcement of the composite deck. Concrete of strength classes from B20 to B40 is located into sections with layers of thickness from 80 to 110 mm. Lightweight concrete is accepted to use with unit mass not less than 1800 kg/m^3 and compressive strength not less than 17 MPa.
Composite behaviour between steel sections and concrete is ensured (after it became hard) by corrugated steel strips of width from 30 to 50 mm as transverse pieces of cold - formed profiled sheets of thickness 0,8-1,0 mm with trapezoidal waves (Fig. 1) The strips are located along each section and fixed to its wall with pop-rivets or weld spots. Exept concrete sound-proofing or heat insulation layers can be located within depth of the slab.

2.Analysis of the slad

Ultimate desing moment for bending composite slab are calculated as for reinforced concrete structure with external reinforcement assumpting full interaction between steel sections and concrete, provided Eurocode 4 and Building Standard of Russia. Safety factor of steel section as main reinforcement is assumed equal 0,7 .Results of analysis of slabs with sections from steel of thickness 0,8-1,0 mm and concrete of different classes are as given in Table.

3. Testing

Standard full-scale test of new composite slab was carried out to control analysis results.

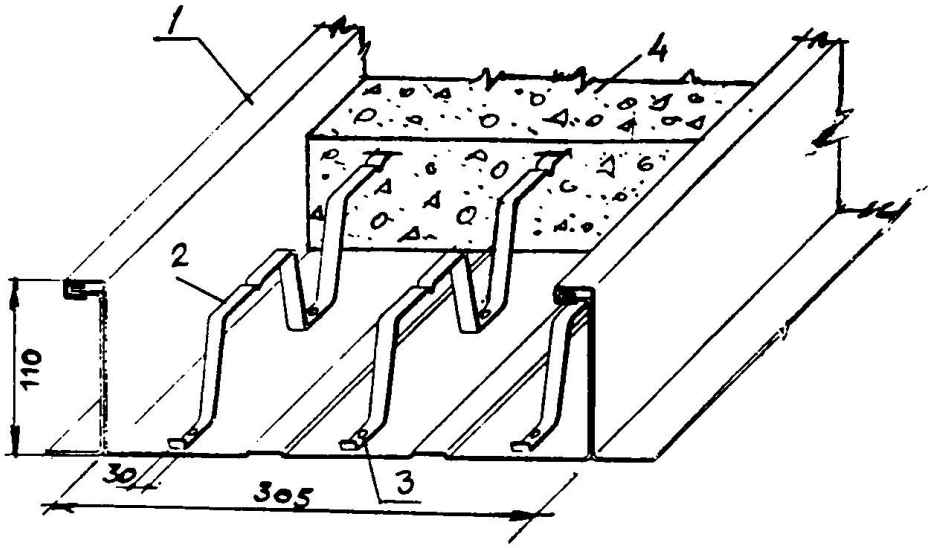

Fig. 1. Anchor connectors in composite slabs
1 - steel section; 2 - anchor; 3 - pop-rivet or weld spot; 4 - concrete

The specimen was represented a simply supported slab with length of 4,1 m, width of 0,9 m and span of 4 m. Thickness of steel sections was of 1,0 mm. Corrugated sheet anchors with width of 30 mm, wave depth of 44 mm and thickness of 0,8 mm are fixed with pop-rivets to the sections, which was filled in with concrete completely. Cubic concrete compessive strength was 20-20,6 MPa (cubics). Two equal concentrated line loads P were applied at thirds of the span. The deflection of the slab at the middle of its span was equal 7,3 mm when P=10 kN, relative movement between the sections and concrete at the ends of the specimen was less than 0,3 mm. Ultimate failure moment on the slab was equal 20,5 kNm (with calculation of its weight).
Recomended maximum span of the new slab is up 4,0 or 5,5 m without or with a temporary support at the middle of the span accordingly during packing of wet concrete.

Thickness, mm		Ultimate desing moment (kNm) on 1 m of slab width for concrete classes				
concrete	section	B15	B20	B25	B30	B40
80	0,8	10,6	10,8	11,1	11,2	11,3
	0,9	11,7	12,0	12,3	12,4	12,6
	1,0	12,8	13,2	13,6	13,7	13,9
110	0,8	14,1	14,3	14,6	14,7	14,8
	0,9	15,7	15,9	16,3	16,4	16,5
	1,0	17,2	17,6	18,0	18,1	18,3

Table 1. Results of analysis of the slabs