APPLICATION OF FIBRE CONCRETE BY REALIZATION OF INDUSTRIAL FLOOR CONSTRUCTION

M. Brodňan [1], P. Koteš [2], V. Zimen [3]

Abstract

The paper describes the experiences with design and realization of industrial floor construction of shopping centre additions store. For the realization of industrial floor construction have been proposed two alternatives for concrete reinforcement. The reinforcing by steel fibres was the first alternative and using of polypropylene fibres reinforcement was the second alternative. The testing of fresh and hardened concrete was implemented in both of these alternatives. More suitable alternative for a specific industrial operation has been chosen according to test results of fresh and hardened concrete and floor contractor experiences.

Keywords: fibre concrete, steel fibres, polypropylene fibres, industrial floor

1. Introduction

The designation „industrial floor“ is used mainly with industrial construction directly in the production or storage. This type of floors are also used in polyfunctional-administrative buildings, residential buildings and where are requirements at high serviceability in its technological parts, as are for example garages, technological rooms, or rooms with special requirements on floor structure and its following surface treatment.

The floors are the only one structural type at building object, which are directly loaded. The exact complex design and professional realisation of industrial floor are unavoidable to fulfil expected ability to transfer the all loads. The reinforcement bars, smeared reinforcement (metallic or non-metallic) or their combination are used for floors reinforcing [1, 2].

In the following parts, the paper is focused on design of the floor skeleton in term of its static resistance and following tests of fresh and hardened concrete. The knowledge from industrial floor structure realisation is shown in conclusion.

2. Design of floor construction

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The design of industrial floor construction of shopping centre addition store was realised in cooperation with company Bekaert [3]. The area load of 90.0 kN/m^2, the high-fork lift with gross lifting capacity 4.0 tons (46 kN/wheel) and loading by shelves (50 kN/middle strut) were used as action on the floor. Company Proreco, s.r.o. realised the floor construction.

2.1 Composition of floor construction

The composition of the floor construction consists of ballast bed, polyethylene separable sheet (thickness of 0.1mm), reinforced slab (thickness of 180mm), cementing powder Panbex F2 and hardened lacquer Panbexil.

2.1.1 Concrete of floor construction

The basic ingredients of fresh concrete C20/25 - XC1 (SK) - Cl 0.4 - D_{max} 16 - S3 on 1 m^3 are shown in table 1. The cement (CEM II/B-S 42.5 N) from cement company Ladce was used for concrete manufacture. The ideal bulk density of fresh concrete was ρ_i = 2280 kg.m^{-3}.

Tab. 1 Ingredients of fresh concrete

Fraction of aggregate [mm]	**Weight [kg]**
0 - 4	530
0 - 2	435
4 - 8	280
8 - 16	610
Cement	**Weight [kg]**
CEM II/B-S 42.5 N	260
Mixing water	**Cubature [l]**
Clear water	165
Additives	**Weight [kg]**
Superplastificator	1.2

2.1.2 Reinforcement of floor construction

The function of the smeared reinforcement is to eliminate or to restrict the cracks during ageing of fresh concrete. Additional functions of the smeared reinforcement are to increase the tension strength, flexural tension strength and resistance against impact and abrasion.
The metal fibres type of Dramix® RC - 65/60-BN [4] in the total amount of 25 kg/m^3 were designed in the floor by company Bekaert [3]. The fibres RC - 65/60-BN are cold drawn worked steel fibres, which are stuck into package by washable glue. The washable glue ensures the fast and simple segregation in concrete and ideal fibres dispersion.

The specimens with polypropylene fibres KrampeFibrin® PF 18/50 [5] were made by reason of properties comparison of fresh and hardened concrete.

The alternative of steel fibres reinforcing of concrete was chosen for realisation on the basis of fresh and hardened concrete tests results.

2.1.3 Cementing powder of floor construction

The cementing powder Panbex F2 of stone colour was used in additions store of shopping centre. It is a pre-mixed fireproof powder mixture containing sorted hard fillers based on sintered oxides, special cements and compatible chemical ingredients. Panbex F2 is poured and smooth in freshly laid concrete slab in the total amount of 5 kg/m^2. Abrasion resistance is max. 0.04 mm and compression strength is min. 75 N/mm^2 after 28 days.

2.1.4 Hardened lacquer of floor construction

The sealing lacquer Panbexil was used as upper layer of floor construction. It is clear acrylic resin grout, which harden, seal and treat the concrete surface and create the durable, resistant and non-dusty surface. The total amount 0.10 till 0.20 l/m^2 is used on one feed. Time of drying up is approximately 2 till 4 hours at temperature 20 °C.

2.2 Result of fresh and hardened concrete tests

The degree of concrete consistence was verified by slump test. The designed slump S3 according [6] was declared by concrete plant. In the case of plain concrete, the slump 130mm was measured. This value fulfils the degree of slump S3. In the case of concrete with polypropylene fibres, the slump 60mm was measured. This value fulfils the degree of slump S2. In the case of concrete with metal fibres, the slupm test was not realised.

The concrete compression strength on cubes with edges 150 mm according [7] was found out at hardened concrete tests. The concrete flexural tension strength on beams with dimensions 100 x 100 x 400 mm according [8] was also investigated. The results of the tests are shown in the table 2 a 3.

Tab. 2 Results of compression strength tests

Number of specimen	b [mm]	h [mm]	v [mm]	F [kN]	f_{ck} [N/mm^2]	m [kg]	ρ [kg/m^3]
Plain concrete							
1	149.60	150.20	149.30	787.50	35.10	7.890	2350
2	149.60	149.40	149.40	799.20	35.50	7.835	2350
3	149.90	150.60	150.00	827.70	36.80	7.980	2360
Concrete with polypropylene fibres							
4	149.60	149.90	149.40	724.90	32.20	7.860	2350
5	149.50	149.40	149.50	756.10	33.60	7.790	2330
6	149.50	149.50	149.40	748.30	33.30	7.860	2350
Concrete with metal fibres							
7	149.80	150.20	150.00	637.70	28.30	7.840	2320
8	149.90	150.40	149.70	617.60	27.40	7.860	2330
9	149.60	149.50	149.70	663.80	29.50	7.845	2340

Tab. 3 Results of flexural tension strength tests

Number of specimen	b [mm]	h [mm]	L [mm]	F [kN]	f_{ctm} [N/mm^2]	m [kg]
Plain concrete						
1	100.60	99.30	399.70	12.40	5.60	9.725
2	100.30	100.70	399.00	10.90	4.80	9.625
Concrete with polypropylene fibres						
3	100.70	100.30	399.70	12.50	5.50	9.515
4	100.40	100.30	399.70	10.20	4.50	9.580
Concrete with metal fibres						
5	100.10	100.00	400.00	10.10	4.50	9.310
6	100.40	100.40	399.30	10.00	4.40	9.415

The results of realised test on specimens from plain concrete and on specimens from concrete with smeared reinforcement fulfil the required values according standard [6]. In the case of cubes and beams strength tests, it was expected that the final strength values of specimens with smeared reinforcement are higher then the values of specimens from plain concrete. The real calculated values not entirely satisfy our expectations. It could be caused by incorrect technique of sampling, eventually, incorrect compress of samples at feeding of forms with fresh concrete.

3. Realisation of floor construction

The traffic of fresh concrete at construction was realised by mobile concrete mixers. The metal fibres were added into fresh concrete directly at construction. The concrete spreading by mobile pump was realised after exhaustive shuffle of concrete with fibres (Fig. 1).

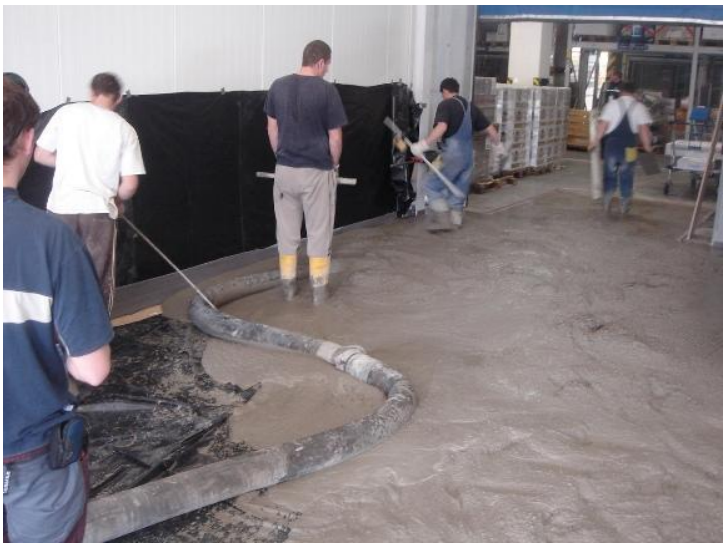

Fig. 1: Fresh concrete working-up

The fibre concrete was post processed by rotary levelling laser. The worker by reader puts the height of layer by set of targets. He creates the cakes with diameter 500 till 700 mm cross marked by removing or adding of concrete. Following, the aligned layer was compressed by floating oscillating lath. The maximum working performance at hand-work is 2500 m^2/day.

The final treatment of surface by rotary iron was started circa after 7 hours after fresh concrete compressing. The surface is smooth by plate of rotary iron (Fig. 2). Next, the cement powder is applied (if it was not applied by machine). The final phase is smoothed only on rotary iron flies. After smoothing, the hardened lacquer is applied.

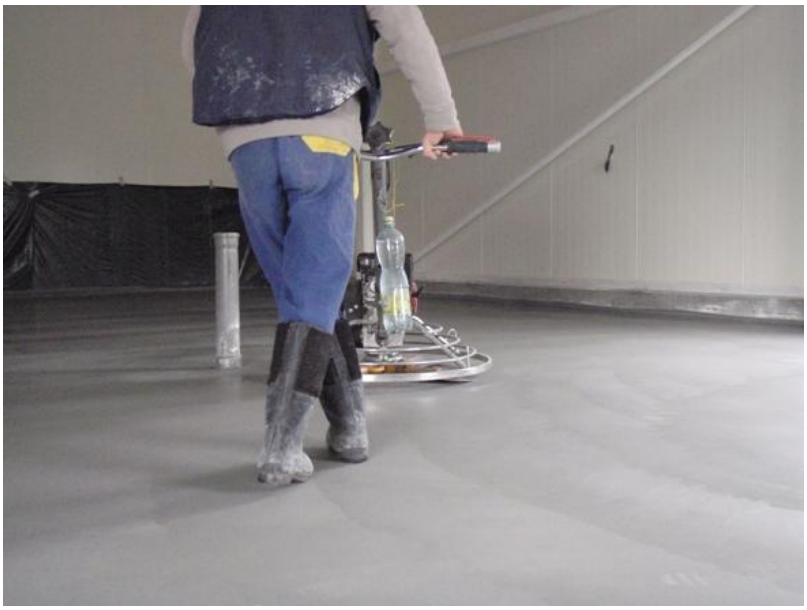

Fig. 2: Surface treatment by rotary iron

The joint clearances are cut circa after 12 hours after smoothing to avoid of crack formation. The surface treatment and protection is started at once after cutting the joint clearances or after hardened lacquer drying. It is necessary to restrict the ineligible tension strengths in concrete composition, which are able to originate by express surface drying or its freezing.

The joint clearances were cut by circular saws with diamond panelling and with dry. The depth of cut was into third of floor slab depth. The spacing of joint clearances is usually 5 till 10 m. The aspect ration is square or rectangle. The joint clearances are cut in the time, when the concrete has optimal strength to prevent the concrete failure near cutting. It is convenient to fill the cutting joint by soft PVC profiles. The joints are sealed by polyurethane mastic after shrinkage process termination after circle 1 month.

4. Conclusions

The aim of the paper was to describe the most used materials for industrial floor construction realisation and to design convenient alternative on particular industrial operation.

The floors in industrial objects are realised in our country due to large construction of industrial parks and due to flow of foreign investors. This branch is still changed. It is caused mainly by variable technology and by delivering of new materials. In the last, the industrial floors were explicitly hand-made. New concrete plants at good condition are built with new technology flow. Also, the realisation of big areas as industrial parks is changed. At this time, the machine realisation is used. This technology allows processing more concrete volume. Therefore, the faster realisation of floor is ensured. The quality of industrial floors is developed by great speed. It is caused by more quality materials as cement powder or used reinforcement fibres. Last but not least, it is caused also by higher quality of concrete and using of concrete higher strength.

Acknowledgements

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5. References

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