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SPECIFIC FEATURES OF THE TECHNOLOGY OF USING MIXED REINFORCED CONCRETE FLOORINGS IN THE CONSTRUCTION OF MULTI-STORY RESIDENTIAL BUILDINGS

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Abstract:
The technology of constructing cast reinforced concrete floors is currently one of the most promising. This advanced direction allows for the construction of multi-story residential buildings with a monolithic reinforced concrete frame with minimal labor and time expenditure, obtaining flexible architectural and planning solutions, which ensures the architectural appeal of buildings and the possibility of free planning of apartments. The technology of constructing cast reinforced concrete floors in the design of multi-story residential buildings provides the following possibilities:

Keywords: Cast reinforced concrete floor, multi-story residential buildings, Heinze Cobiax International GmbH, Nautilus, BubbleDeck

Introduction

The technology of constructing cast reinforced concrete floors is currently one of the most promising. This advanced direction allows for the construction of multi-story residential buildings with a monolithic reinforced concrete frame with minimal labor and time expenditure, obtaining flexible architectural and planning

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solutions, which ensures the architectural appeal of buildings and the possibility of free planning of apartments.

The technology of constructing cast reinforced concrete floors in the design of multi-story residential buildings provides the following possibilities:

- obtaining spacious apartments due to the large spacing of load-bearing structures and their free layout;
- design of kitchens with an area of 12-15 m, two toilets in one apartment (hotel and host's restroom), spacious halls, loggias;
- placement of the building in two floors.

Currently, the use of cast reinforced concrete floors in the construction of multi-story residential buildings has a wide variety of applications [1-5].

Materials and Methods

The technology for obtaining hollow slabs, proposed by Heinze Cobiax International GmbH, is based on the removal of concrete from the "non-working" central part of the floor slab. This is achieved by placing specially shaped plastic cavity formers inside the cast plate.

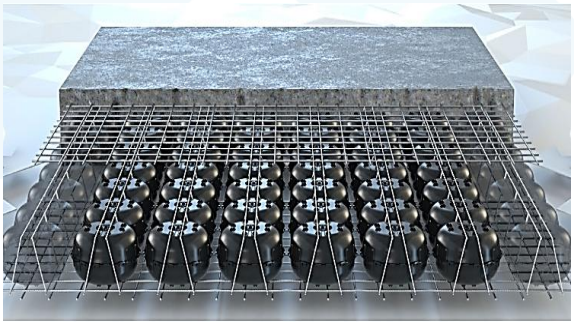

Figure 1 - Schematic view of the "Cobiax" structural system

An important feature of Cobiax technology is the ability to build environmentally friendly buildings that meet high LEED, DGNB, and BREEAM ratings. The environmental friendliness of the solution is associated with minimizing the

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volume of concrete required for construction. Thus, Cobiax improves the building's environmental rating at the construction stage.

Concrete production and its delivery to the construction site are environmentally harmful processes. According to the manufacturer, the technology allows for a 25-35% reduction in concrete volume. This, in turn, will reduce the consumption of non-renewable resources by 22 percent and reduce carbon dioxide emissions by 20

Modular mold made of recycled polypropylene - the basis of the constructive system "Nautilus"

(Fig. 2) designed to facilitate the casting of reinforced concrete slabs in place

New generation of non-removable plastic molds for lightweight floor slabs innovative format of the space generator construction projects.

The Nautilus allows for a significant reduction in floor slab mass and comprehensive optimization.

Spectrum of construction parameters, in which the insolvable floor slab molds [1, 2].

Mold cavity formers are made of new processed polypropylene.

Sample: waterproof with high strength and lightness.

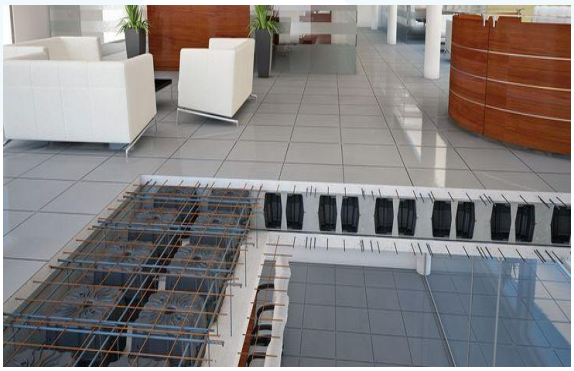

Figure 2 - View of the Nautilus structural system

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Bubble Deck is an innovative, patented concrete floor system that uses hollow, high-density plastic balls (cavity formers) mounted on double-sided slabs, which, while maintaining strength, significantly reduces weight, provides longer spans, fewer columns, and architectural freedom. This leads to lighter and more efficient structures, lower material costs (less concrete consumption), faster construction (prefabricated panels), and improved energy efficiency, making it ideal for various buildings such as parking lots, high-rise buildings, and educational institutions [6-11].

Analysis of Results

• Creating space: Large, hollow plastic balls are used to replace the concrete in the center of the slab, where concrete is structurally unnecessary .

• Steel grid: The balls are held inside a steel grid and form a lightweight, biaxial plate.

• Installation: Ready-made panels are placed

Figure 3 - View of the BubbleDeck structural system

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Below is the calculation of the reinforced concrete floor

(Table 1)

	MONOLITHIC FLOORINGS						
39	E6-1-122-1 SHNK.DOP.4	CONSTRUCTION OF REINFORCED CONCRETE FLOORS IN PERI TYPE FORMWORK /CONCRETE SUPPLY BY A CONCRETE PUMP/ THICKNESS UP TO 200 MM	100M3	2.66		15352,75	408 383 210
39.1	000001	LABOR COSTS OF CONSTRUCTION WORKERS WITHOUT TAKING INTO ACCOUNT SOCIAL INSURANCE	PERS HOUR	743.85	1978,641	17,135.67	33 905 339
39.2	000003	LABOR COSTS OF MACHINE OPERATORS	PERS HOUR	30.51	81,1566	0.00	0
39.3	000112	5 T FORKLIFT TRUCKS	CAR C	0.82	2,1812	115,079.22	251 011
39.4	000403	DEEP VIBRATORS	CAR C	6	15.96	1,183.79	18,893
39.5	000698	TOWER CRANES FOR WORK ON OTHER TYPES OF CONSTRUCTION (EXCEPT INSTALLATION OF TECHNOLOGICAL EQUIPMENT) 8 T	CAR C	25.05	66,633	77,046.76	5,133,857
39.6	001439	MANUAL PIPE BENDING MACHINES	CAR C	12.06	32,0796	11,350.64	364 124
39.7	001523	ELECTRIC CIRCULAR SAW	CAR C	4.24	11,2784	1,003.21	11,315
39.8	001572	SPRAY GUNS	CAR C	6.96	18,5136	1,152.00	21,328
39.9	002577	GAS WELDING AND CUTTING MACHINES	CAR C	17.02	45,2732	1,375.83	62,288
39.10	002769	REBAR CUTTING MACHINE	CAR C	8.13	21,6258	12,181.87	263,443
39.11	002777	PUTZMEISTER CONCRETE PUMP, PRODUCTIVITY 110-120 M3/HOUR	CAR C	1.6	4,256	661,546.00	2,815,540
39.12	002875	ELECTRIC PERFORATORS	CAR C	1.9	5,054	1,126.46	5,693
39.13	002882	Step-down transformers, voltage 380/36 V, oil-filled, power up to 30 kW	CAR C	6	15.96	1,682.00	26,845
39.14	030407	CONSTRUCTION NAILS	T	0.002	0.00532	10 550 000	56 126
39.15	030865	Laminated plywood, 21 mm thick	M3	0.6955	1,85003	128,451.00	237,638
39.16	030896	PERI BIO CLEAN FORMWORK LUBRICANT	T	0.0081	0.021546	6,200,000.00	133,585
39.17	032543	LIGHT WIRE DIAMETER 1.1 MM	T	0.0167	0.044422	7,752,000.00	344 359
39.18	035516	MAT	M2	33.33	88,6578	5,500.00	487 618
39.19	045014	HEAVY CONCRETE (PROJECT CLASS)	M3	101.5	269.99	294,643.00	79 550 664
39.20	045404	CARTRIDGES FOR CONSTRUCTION AND ASSEMBLY GUN	1000 PCS	0.0948	0.252168	50,000.27	12,608

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39.21	052641	CAST IRON SEWER PIPES 2 M LONG, 100 MM DIAMETER	M	2.84	7,5544	44,423.00	335,589
39.23	094542	Low-pressure polyethylene pressure pipes of medium type, with an outside diameter of 32 mm	10M	2,371	6,30686	3,963.00	24,994
40	C124-9220	REINFORCEMENT FOR MONOLITHIC REINFORCED CONCRETE STRUCTURES IN THE FORM OF NETS AND FLAT FRAMEWORKS, PERIODIC PROFILE CLASS AIII, DIAMETER 10 MM	T	22,686405		7,812,500.00	708 950 156
41	C124-9223	REINFORCEMENT FOR MONOLITHIC REINFORCED CONCRETE STRUCTURES IN THE FORM OF NETS AND FLAT FRAMEWORKS, PERIODIC PROFILE CLASS AIII, DIAMETER	T	3.41678		7,678,571.00	104 943 51
42	C124-9222	REINFORCEMENT FOR MONOLITHIC REINFORCED CONCRETE STRUCTURES IN THE FORM OF NETS AND FLAT FRAMEWORKS, PERIODIC PROFILE CLASS AIII, DIAMETER 14 MM	T	2,02456		7,678,571.00	62 182 911
43	C124-9221	REINFORCEMENT FOR MONOLITHIC REINFORCED CONCRETE STRUCTURES IN THE FORM OF NETS AND FLAT FRAMEWORKS, PERIODIC PROFILE CLASS AIII, DIAMETER 12 MM	T	1.65212		7,812,500.00	51 628 750
44	C124-9223	REINFORCEMENT FOR MONOLITHIC REINFORCED CONCRETE STRUCTURES IN THE FORM OF NETS AND FLAT FRAMEWORKS, PERIODIC PROFILE CLASS AIII, DIAMETER 18 MM	T	0.25888		7,678,571.00	7,951,314
45	C124-9218	REINFORCEMENT FOR MONOLITHIC REINFORCED CONCRETE STRUCTURES IN THE FORM OF NETS AND FLAT FRAMEWORKS, PERIODIC PROFILE CLASS AIII, DIAMETER 6 MM	T	0.20774		8 216 286,00	6 827 405
		TOTAL COSTS:					
		LABOR COSTS OF WORKERS	MAN-HOUR				1979
		SALARY	SUM				33 905 339
		OPERATION OF MACHINES	SUM				8 974 336
		CONSTRUCTION MATERIALS	SUM				1,023,667,669
		TRANSPORTATION COSTS	SUM				60,485,938
		TOTAL	SUM				1 127 033 282

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FLOOR SLABS AT CLEARANCE

(Table 2)

154	E7-5-45-5	INSTALLATION OF FLOOR PANELS WITH SUPPORT ON TWO SIDES WITH AN AREA OF UP TO 10 M2	100 PCS	1.8		18,270,860.59	32 887 549
154.1	000001	LABOR COSTS OF CONSTRUCTION WORKERS WITHOUT TAKING INTO ACCOUNT SOCIAL INSURANCE	PERS HOUR	274	493.2	19,121.47	9 430 709
154.2	000698	TOWER CRANES FOR WORK ON OTHER TYPES OF CONSTRUCTION (EXCEPT INSTALLATION OF TECHNOLOGICAL EQUIPMENT) 8 T	CAR CLOCK	51.21	92,178	77,046.76	7 102 016
154.3	006317	Heavy concrete class B12.5 /M-150/ fractions 5-20mm	M3	6.5	11.7	294,643.00	3,447,323
154.4	012226	READY-MADE CEMENT MASONRY MORTAR, GRADE 100	M3	2.06	3,708	387,316.00	1,436,168
154.5	030407	CONSTRUCTION NAILS	T	0.0013	0.00234	10,550,000.00	24,687
154.6	032208	Solidol grease "Zh"	T	0.009	0.0162	3,800,000.00	61,560
154.7	036049	Softwood lumber. Edged boards 4-6.5 m long, 75-150 mm wide, 19-22 mm thick, grade III	M3	0.33	0.594	3,750,000.00	2,227,500
154.8	043232	PAINT ACCORDING TO DESIGN DATA	T	0.009	0.0162	14,800,000.00	239,760
154.10	050777	Auxiliary structural elements, predominantly made of rolled profiles, assembled from two or more parts, with or without holes, connected by welding	T	0.43	0.774	11,521,739.00	8 917 826
155	402-591	Hollow-core floor panels 2PK 53.12-8A380-C8	PC	96		890 400,00	85,478,400
156	402-1132	Hollow-core floor panels 2PK 59.10-8A380-C9	PC	48		1,209,903.00	58,075,344
157	402-1133	Hollow-core floor panels 2PK 59.12-8A380-C9	PC	36		1,331,621.00	47 938 356
158	E7-5-45-4	INSTALLATION OF FLOOR PANELS WITH SUPPORT ON TWO SIDES WITH AN AREA OF UP TO 5 M2	100 PCS	1.44		14,747,787.96	21,236,815
158.1	000001	LABOR COSTS OF CONSTRUCTION WORKERS WITHOUT TAKING INTO ACCOUNT SOCIAL INSURANCE	PERSON HOUR	210	302.4	19,121.47	5,782,333
158.2	000003	LABOR COSTS OF MACHINE OPERATORS	PERSON HOUR	33.6	48,384	0.00	0
158.3	000698	TOWER CRANES FOR WORK ON OTHER TYPES OF CONSTRUCTION (EXCEPT INSTALLATION OF TECHNOLOGICAL EQUIPMENT) 8 T	CAR CLOCK	32.18	46,3392	77,046.76	3,570,285
158.4	006317	Heavy concrete class B12.5 /M-150/ fractions 5-20mm	M3	4.13	5,9472	294,643.00	1,752,301
158.5	012226	READY-MADE CEMENT MASONRY MORTAR, GRADE 100	M3	1.76	2,5344	387,316.00	981 614
158.6	030407	CONSTRUCTION NAILS	T	0.0013	0.001872	10,550,000.00	19,750
158.7	032208	Solidol grease "Zh"	T	0.008	0.01152	3,800,000.00	43,776

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158.8	036049	Softwood lumber. Edged boards 4-6.5 m long, 75-150 mm wide, 19-22 mm thick, grade III	M3	0.33	0.4752	3,750,000.00	1,782,000
158.9	043232	PAINT ACCORDING TO DESIGN DATA	T	0.008	0.01152	14,800,000.00	170,496
158.11	050777	Auxiliary structural elements, predominantly made of rolled profiles, assembled from two or more parts, with or without holes, connected by welding	T	0.43	0.6192	11,521,739.00	7,134,261
159	402-1043	Hollow-core floor panels 1PK 35.10-8A380-C8	PC	24		455,000.00	10,920,000
160	402-1044	Hollow-core floor panels 1PK6 35.12-8A380-C8	PC	108		546,000.00	58,968,000
161	402-1129	Hollow-core floor panels 1PK6 29.12-8A380-C8	PC	12		722 724.00	8 672 688
		TOTAL COSTS:					
		LABOR COSTS OF WORKERS	MAN-HOUR				796
		SALARY	SUM				15,213,042
		OPERATION OF MACHINES	SUM				10 672 301
		CONSTRUCTION MATERIALS	SUM				298 291 809
		TRANSPORTATION COSTS	SUM				8 948 754
		TOTAL	SUM				333 125 906

Conclusion

The use of cast-in-place reinforced concrete frames in the construction of multi-storey residential buildings is one of the most promising, industrial and competitive technologies currently available. It allows for large spans between columns, optimizing the design of buildings, rapid expansion of volume, reducing construction times and reducing costs. This article reviews the technologies for constructing multi-storey residential buildings from cast-in-place reinforced concrete frames, such as the Heinze Cobiax International, Nautilus, BubbleDeck systems. Their design features are identified and their advantages and disadvantages are discussed. A comparison of the cost of constructing buildings using precast-monolithic technology with the cost of constructing the same buildings using monolithic and prefabricated construction technologies is made, which demonstrates the advantage of the former. Thus, the cost of such

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construction is on average 20% (and in some cases 30%) lower than the other technologies discussed.

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