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Energy Efficiency Methods of Keeping Fresh Concrete in the Construction of Monolithic Structures.

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Abstract: *The article contains a description of some features of erection building constructions. Special attention is paid to technology and methods of warming up of concrete. Conditions of efficiency of production work.*
Key words: *energy efficiency, monolithic constructions, concrete mix, winter concreting.*

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Construction of monolithic concrete and reinforced concrete structures in winter conditions can be done using several methods of winter concreting.The choice of method should be made taking into account the requirements of the law of the Russian Federation on the basis of feasibility studies and minimum values of energy intensity, labor intensity, cost and duration of work, as well as taking into account the temperature and humidity conditions of concrete hardening at the construction site. It is often methods of winter concreting, according to the feasibility study. It is a combinationof two or more traditional methods, which include:

Table 1: Combined winter concreting techniques

№	Method	Applicationarea		Approximate additional costs for 1 m3 of concrete		Additionalinformation
		modulosurfaces tructures	byoutdoor temperatu-re, ° C	energy, thousan dkJ	workpeopl e/H	
1	Thermos	To 2	To -20	237	1,7...2,14	The easiest way to produce work. Necessityineffectiveinsulatio n.
		To 6	To -10			
2	Thermoswithadditivesacceler ators	To 5	To -40	–	1,6…2,2	It is necessary to prepare concrete with antifreeze additive. Ease of production at the construction site.
		To 8	To -20			
3	Antifreezeadditives	Withnorestrictio ns	To -20	88	1,8….2,2	The slowed rate of hardening of concrete. Ease of production at the construction site.
			To -25			
4	Preliminaryelectric heating of concrete mix	To 4	To -25	188	2,2….2,9	The need for large electrical facilities.
		To 12	To -5			
5	Through electric heating using rod electrodes	Withnorestrictio ns	Withnorestric tions	175	7,1….8,6	Themostcommonway.
6	Peripheral electrical heating using strip electrodes	Withnorestrictio ns	Withnorestric tions	176	4,8….5,9	Ease of production at the construction site.
7	Heating in thermoactive formwork	Withnorestrictio ns	Withnorestric tions	177	4…4,8	The greatest ease of work on the construction site compared to other methods of electrical concrete treatment in construction.

[1]Note. The table shows data for structures with a surface module of 4 ... 6, in formwork with a heat transfer coefficient of 3.6 W / (m2, ° C), at an outdoor temperature of -15 ... -20 ° C.

Hardening of fresh concrete on modern Portland cement is a fairly long process with low positive (≤ 5 ° C) and, especially, negative air temperature.Therefore, in the winter period, it is necessary to use technical means that provide accelerated hardening of the concrete of monolithic reinforced concrete structures [2,3,4].Achieving this goal may be due to improved or quick-hardening cements, chemical additives - antifreeze and accelerated solids, which allows to increase the dosage of cement and natural water-cement relations using a higher grade compared to the design mark [2].

In our opinion, the most optimal and economic method is the application of thermal methods of accelerating the hardening of concrete in the absence of reliable and inexpensive chemical additives. This technology is resource-saving, so this price of costs allows to: reduce the construction time by 5-10 times; efficient use of labor resources and equipment, including capital-intensive formwork; apply cheaper additional concrete mixes; eliminate the possibility of concrete freezing at an early age and ensure the required quality of concrete and structures.

At the same time, different thermal methods can be applied to the heating of concrete in monolithic structures, and each of them has own characteristics in terms of equipment, application technology and energy characteristics.The decisive factors in choosing the heating method are the scale of the construction object, the type of construction, energy intensity and reliability of the method, capital and labor costs [7,8,9].

The methods of convective heating of structures with an external heat conductor in an artificially created heat chamber are universal, i.e. applicable to any structures regardless of the method of concreting, the method of reinforcement and the type of formwork.

Convective heating of floors is carried out with the help of heat generators placedfrom below in the bottom of a tarpaulin room.

Theconcretesurfaceoftheceilingiscoveredwiththermalinsulatingpolyethylenefoamorotherheat-shieldingmaterialwith a thermalresistanceofatleast 0.3 m2 C / W.

Heatisproducedbyfueloilheatgeneratorswith a heatoutputof 25.46 and 93 kW, or 22.40 and 80 thousandkcal / h.

Convective heating of the floor with thickness of 200 mm at an air temperature of -10 ... 15 ° C hasthefollowingcharacteristics:

- specific fuel consumption 8 l / m3;
- power density - 3-4 kW / m3 or 0.6-0.8 kW / m2. [3]

Convective heating of walls is carried out with the help of electric heaters placed at the base of the walls on two sides under a canvas cover.

For this purpose we use electric panel heaters with a power of 3 kW, developed by the science and technology center “ETEKA”. The voltage to the heaters is supplied using extension cables with connectors connected to the control cabinet.

The specific poweris 6-9 kW / m3 that ensures the achievement of standard strength for two days at an ambient temperature of -10 ... 15 ° Cforwallswithathicknessof 200-300 mm.[4,5,6,9]

Convective heating of the columns: heating is carried out using panel electric heaters with a power of 2.4 kW, installed at the base of the column and covered with a tarpaulin.

The heater power per column is 2.4-7.2 kW and depends on the volume of the column, the ambient temperature and the warm-up time to 20 ° C.

The heating wire ispractically convenient, reliable and versatile way of heating monolithic concrete. We use heating wires of the PNSV-1,2 (1,4), POSHV, POSHP, PVZh, PPZh, PTPZh-2H1,2, PRSP [5,6,7], etc. brands. As experience shows, the thermal regime provides the concrete heats up fairly evenly throughout the structure that based on the use of peripheral heat of the heating wire and heat of hydration of cement.Therefore, the temperature and thermal deformations over the volume of the structure vary quite uniformly and can`t be the cause of the appearance of temperature cracks in the protective layer.

The reason for the appearance of surface cracks may be the insufficient tensile strength of concrete during the rapid cooling of a large surface of concrete that has been disassembled and not covered by the insulating material if its surface temperature, reduced by the outside air temperature, exceeds the standard value. Compliance with the rules and regulations [6, 7, 8, 9] for the care of concrete after demoulding ensures a defect free.

- Type of commonly used wire - PNSV 1.2 or 1.4.
- Voltage applied to the wire, V - 50-100.
- Specific required power, kW / m3 - 2-3.
- Wire consumption, m / m3 - 50-60.
- Exposure cycles of structures, days - 2-3.
- Additionalequipment: transformer, trunkcables, meansofthermalprotection.

This method is universal, but at the same time more laborious, as it requires accuracy when laying the wire and preserving it when concreting the structures.

Thewarming methodofreinforced concrete construction is the most energy efficient. Itcouldbe realizedbya formwork, thatitisa heat generator and thermal protection.
Theuseofthismethodislimitedto a setofstructureswithunchangingformworkgeometry (forexample: columns, fragmentsofrepetitivewall-capturing, floorslabs, andotherstructuresofthesametype).

The specific power of the thermal shutter or thermal board is 300-800 W / m2for the realization of a 2-3-day cycle of hardening of concrete in conditions with a negative temperature.
At present, the heating of columns is done in thermoactive formwork, equipping with evenly distributed flat electric heaters that create a uniform heating field for the entire surface.
Technical and economic indicators of all known methods of heating concrete monolithic structures are given in table [2]. The data in this table reflect the energy intensity and level of monetary costs, which is very important in choosing a method.

Technical and economic indicators of the method of heating monolithic reinforced concrete structures in the winter.Таблица 2

№	Methods for heating monolithic reinforced concrete structures	Technical specific characteristics of the methods at tbn = 10 ° C; tv = -10 ° C; Vt = 1 ° C / h; Dtб = 20 ° C; d = 200 mm; Mp = 10				Energy costs, rubles / m3 (tariffs until December 2000)	Additional electric power (gripper 30m3)	Cost estimate for equipment, materials (object - 6,000 m3 of concrete, stacked in winter), ths. Rub.
		Power, kW / m3	Energyandfuelconsumption					
			KW· h/m3	l/м3	Kg W / m3			
	1	2	3	4	5	6	7	8
1	Methods of heating walls, columns, base plates, etc.							
1.1	ConvectionHeated	6	120	–	38	76,8	180	220
1.2	Electricalheatingwire	2 (50 l.m / m3)	50	–	16	32	60	250
1.3	Heatedintemroaktivnoyformwork	3	60	–	19	38,4	90	300
1.4	Electricheatingconcretemix	120 (15 min)	30	–	10	19,2	120	450
1.5	Steamheatingconcretemix	–	н	6-8	10	35	–	450
2	FloorHeatingMethods							
2.1	Heating with the use of diesel heat generators	–	–	8-10	12	45	–	250
2.2	Electricalheatingwire	2	50	–	16	32	60	250
2.3	Electroheatingelectrode	3 (10 h)	30	–	10	19,2	90	250
2.4	Thermoactive flexible coatings with fabric carbon electric heaters	3	25	–	14	30	90	250

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