



SCIENTIFIC AND TECHNICAL JOURNAL
Namangan Institute of Engineering and Technology

«ENERGY-SAVING MODES OF THE HEAT TREATMENT OF
CONCRETE»

Raximov Akmalkhon	Professor
Khusainov Mukhammadalikhon	Associate Professor
Turgunpulatov Mirzohid	Teacher
Khusainov Sarvarkhon	Teacher
Gaybullayev Akramkhon	Master student

Namangan Institute of Engineering and Technology

<https://doi.org/10.5281/zenodo.7952056>



ISSN 2181-8622

Manufacturing technology problems



**Scientific and Technical Journal
Namangan Institute of
Engineering and Technology**

**Volume 8
Issue 1
2023**



UDC 691.327.624.072

ENERGY-SAVING MODES OF THE HEAT TREATMENT OF CONCRETE

RAXIMOV AKMALKHON

Professor of Namangan Engineering and Construction Institute

KHUSAINOV MUKHAMMADALIKHON

Associate Professor of Namangan Engineering and Construction Institute

TURGUNPULATOV MIRZOHI

Teacher of Namangan Engineering and Construction Institute

KHUSAINOV SARVARKHON

Teacher of Namangan Engineering and Construction Institute

GAYBULLAYEV AKRAMKHONMaster student, Namangan Engineering and Construction Institute
E-mail: khusainov1962@gmail.com, phone: (+99894) 305-24-58**Abstract:**

Objective. The precast concrete industry is one of the largest consumers of energy among other sectors of the national economy. Heat treatment is an integral and at the same time the longest and most energy-intensive process of precast concrete production. In this regard, based on the determination of optimal steaming modes in a hot climate, it will lead to savings in energy costs, which is the purpose of this study.

Methods. To determine the effect of high outdoor temperature in a hot climate (30...35 °C) on the process of concrete hardening during heat and moisture treatment during the experiment in the climate chamber, the composition of aggregates and binder material was selected. The composition of concrete on Portland cement is 1:2.69: 4.58, on slag Portland cement 1:2.37 : 4.1. The initial temperature of the concrete mixture was taken equal to 15..20, 20...25 and 25...30 °C. Cube samples with an edge of 10 cm were tested for compressive strength 4 hours after heat and moisture treatment and after 3 and 28 days.

Results. Research results have shown that the higher the initial temperature of concrete, the greater the strength it gains after heat and moisture treatment. By the end of the heat and moisture treatment, concrete with an increased initial temperature gains a large amount of degree-hours compared to concrete with a lower initial temperature and, accordingly, leads to energy savings during heat treatment, since the strength indicators are 70 and 61% of R28nt.

Conclusion. The assignment of heat and moisture treatment modes for precast concrete products, taking into account the ambient temperature of a hot climate, reduces the time of the active cycle (temperature rise + isothermal heating) for 2...3 hours. The reduction of energy consumption at the same time is 20... 22%.

Keywords – Energy Efficiency, Concrete, Climate, Temperature, Industry, Reinforced Concrete, Technology.

Introduction. The Republic of Uzbekistan has adopted a number of key decrees aimed at improving energy efficiency in the sector of the economy and the social sphere, introducing energy efficient and energy saving technologies, further developing renewable energy, and

ensuring the rational use of energy resources.

The precast concrete industry is one of the largest energy consumers among other sectors of the national economy. At present, heat treatment is an integral and at the same time the longest process in the production of precast concrete.

Despite some success, heat and moisture treatment has been and remains the longest technological redistribution of precast concrete production, taking 80-90% of the total time required for the manufacture of products.

Currently, over 90% of factory production is subjected to steaming, and more than half of the total volume is produced according to the aggregate flow technology with heat treatment in pit steaming chambers.

The main advantage of steam heating is the ability to provide suitable moisture conditions for concrete hardening, when the steam is in direct contact with the unformulated surface of the products. The widespread use of steam heating in the production of prefabricated reinforced concrete in our country and abroad is explained not so much by the advantages of the method as by its thorough study and great practical experience.

To accelerate the hardening of concrete in prefabricated structures, steam heat treatment has been used since the beginning of the last century.

Numerous studies have been carried out on this issue, and the method is well described in a number of works by S.A. Mironov, L.A. Malinina and B.A. Krylov [1,2,3].

Depending on the accepted manufacturing technology, the conditions for heat treatment of products change: the concrete is heated either through the metal of the mold, or through direct contact of the product with the coolant. In this regard, the question arose about the processing of optimal steaming modes in relation to specific production conditions. Since the mid-50s of the last century, large studies have been carried out on the effect of elevated hardening temperatures on the phase composition, the structure of new formations, the degree binder hydration and the exotherm of cement.

The international conference RILEM, held in 1964 in Moscow, made a great contribution to the problem. There were

made a number of reports on the choice of cement for heat treatment [4, 5], the processes of hydration of Portland cement during heat and moisture treatment [6, 7, 8], reduction of concrete hardening time [9, 10, 20], temperature gradients in concrete exposed to steaming [19] hardening of concrete in the conditions of Central Asia [11].

In a hot climate, the high temperature of the outside air (30...35 °C) is observed 6...7 months a year. Under such conditions, the temperature of the concrete mixture at the moment of molding reaches 25 ... 30 °C. However, at present, these factors are not taken into account when setting the modes of heat and moisture treatment of concrete, as a result, the duration of heat and moisture treatment and energy consumption at enterprises in the southern and northern regions remain the same.

In order to study the influence of the initial temperature of the concrete mixture and the ambient temperature on the modes of heat and moisture treatment of concrete, we carried out a number of studies.

Methods. Portland cement ($R_{ts}=40.8$ MPa, $S_{sp}=3357$ cm²/g) and slagportland cement ($R_{ts}=33.8$ MPa, $S_{sp}=2593$ cm²/g) were used as binder. The filler was granite crushed stone with a maximum size of 20 mm and quartz sand with $M_k=1.88$. The composition of concrete on portland cement 1: 2.69: 4.58, on slagportland cement 1: 2.37: 4.1. The experiments were carried out in a climatic chamber. The initial temperature of the concrete mixture was taken equal to 15..20, 20 ... 25 and 25 ... 30 °C. A concrete mixture with a temperature of 20 ... 30 °C was prepared with heated water. However, after several tests, a slight decrease in concrete temperature was observed during preliminary curing. It turned out that at the time of preparation, only the mortar part of the concrete was heated. The coarse aggregate warmed up slowly, absorbing heat during the pre-holding, causing the temperature to drop. Considering this, in the future, the large

aggregate and the metal mold will heat up to 30 ... 35 °C.

Then the concrete mixture was quickly placed in a mold, compacted by vibration and placed in a climatic chamber. The temperature of the freshly made concrete mixture was measured with a laboratory thermometer and an ETP-M device. Chromel- Copel thermocouples were installed at characteristic points of the sample. The samples were kept for 2 hours at a temperature of 25... 35 °C (depending on the initial temperature of the concrete mixture) and a relative humidity of 45 ... 50%. After preliminary holding, the samples were steamed in the same chamber.

The temperature rise for all series of experiments was 3 hours at an average rate of 20°C/h, the duration of isothermal heating for concrete on portland cement-2; 4; 6, and on slag portland cement-4; 6; 8 hours. The concrete was cooled for 4 hours at an average rate 10 °C/h using a ventilator or kept for 6 hours with an open control gate of the ventilation duct. The maximum temperature of isothermal heating of concrete samples on Portland cement-80, on slag Portland cement-90 °C.

A KSP-4 device was used to measure and record the temperature in the chamber and in the sample sections. The control and regulation of the temperature in the chamber was carried out automatically by the PRTE-2M software controller. In all experiments, the camera load factor was the same. For the reliability of the results, each series of experiments were repeated several times.

Samples - cubes with an edge of 10 cm were tested for compressive in 4 hours after heat and moisture treatment and after 3 and 28 days. For each batch of the same batch, three samples were molded, which were stored in a normal hardening chamber and tested after 28 days.

Results and discussion. The research results showed that the initial temperature of the concrete mixture significantly affects on the increase in strength of concrete prepared on portland cement (table-1).

The higher the initial temperature of concrete, the greater the strength it gains after heat and moisture treatment. However, after 3 days, the strength of concrete with different initial temperatures leveled off, and after 28 days, concrete gained the same strength regardless of the initial temperature (Fig). This, apparently, is explained by the fact that in concrete with a higher strength after heat and moisture treatment, its further growth occurs more slowly than in concrete with a lower strength. This is consistent with the kinetics of cement hydration. In concretes with greater strength, after heat and moisture treatment, a significant part of the cement grains is hydrated, and around the unhydrated core of the grains, denser shells are formed from the products of cement hydration. These shells further, during hardening, impede the penetration of moisture to the unhydrated parts of the cement grains, slowing down the hardening process. Hence it follows that the greater the strength of concrete after heat and moisture treatment, the less its further growth.

Table 1.

Strength of concrete on portland cement under various modes of heat and moisture treatment

Versions	№ Series	Environment parameters in the chamber during preliminary exposure		Initial temperature of concrete mix T _{c.m.} , °C	V/C	Cone draft, sm	Steaming mode, hour	Compressive strength of concrete, MPa through			
		t, °C	φ, %					4 hours after TBO	3 days	28 days	28 days normal hardening
1	2	3	4	5	6	7	8	9	10	11	12
I	1	15-16	70-75	15	0,65	2-2,5	2+3+6+4	<u>17,4</u> 61	<u>20,3</u> 71	<u>26,8</u> 94	<u>28,5</u> 100
		20-21	70-75	20	0,65	2-2,5	2+3+6+4	<u>18,6</u> 60	<u>22,2</u> 72	<u>29,1</u> 94	<u>31,1</u> 100
II	3	26-28	48-50	22-25	0,65	2-2,5	2+3+6+4	<u>20,5</u> 65	<u>22,1</u> 70	<u>29,4</u> 94	<u>31,4</u> 100
		26-28	48-50	22-25	0,65	2-2,5	2+3+4+4	<u>17,6</u> 57	<u>21,8</u> 69	<u>30,1</u> 95	<u>31,6</u> 100
	5	26-28	48-50	22-25	0,65	2-2,5	2+3+2+4	<u>15,5</u> 49	<u>20,1</u> 14	<u>28,5</u> 91	<u>31,4</u> 100
		26-28	48-50	22-25	0,65	2-2,5	2+3+2+6*	<u>15,1</u> 60	<u>18,2</u> 72	<u>24,8</u> 98	<u>25,3</u> 100
III	7	26-28	48-50	22-25	0,65	2-2,5	2+3+2+6*	<u>17,4</u> 55	<u>21,5</u> 72	<u>29,5</u> 93	<u>31,8</u> 100
		32-34	44-46	28-30	0,65	1,5-2	2+3+4+4	<u>19,7</u> 54	<u>22,5</u> 70	<u>30,1</u> 94	<u>32,0</u> 100
	9	32-34	44-46	28-30	0,65	1,5-2	2+3+2+4	<u>17,4</u> 54	<u>22,2</u> 69	<u>31,0</u> 96	<u>32,2</u> 100
		32-34	44-46	28-30	0,65	1,5-2	2+3+6+4	<u>23,2</u> 70	<u>25,5</u> 77	<u>31,5</u> 95	<u>33,0</u> 100
	11	32-34	44-46	28-30	0,65	1,5-2	2+3+4+6*	<u>21,0</u> 68	<u>22,5</u> 73	<u>29,8</u> 96	<u>31,0</u> 100

Notes. 1). Above the line is the strength of concrete, MPa, below the line -% 2). 6 * Cooling of concrete at an average rate of 3-4 °C/hour for 6 hours was carried out with an open regulating gate of the ventilation duct of the chamber. 3). Concrete in series 1 and 2 are prepared without water heating, i.e. according to conventional technology and pre-conditioned in the workshop for 2 hours under the conditions specified in the table.

From table 1. It can be seen that for all series of experiments the 28-day strength of concrete on portland cement after heat and moisture treatment is 5-9% less than that of normal hardened concrete. The reason for the lack of strength can be two factors. First, heat treatment at high (80 °C) temperature. It is known that heat is a powerful factor in accelerating the hardening of concrete, but also to a certain extent disturbs its structure due to uneven

expansion of the components. This leads to the appearance of stresses in the heterophase system, the appearance of cracks and other microdefects [12, 21]. Secondly, preliminary curing of concrete at a relatively high ambient temperature (25-35°C). It was found [1] that the most favorable results are obtained after preliminary curing of freshly formed products on portland cement at a low temperature.

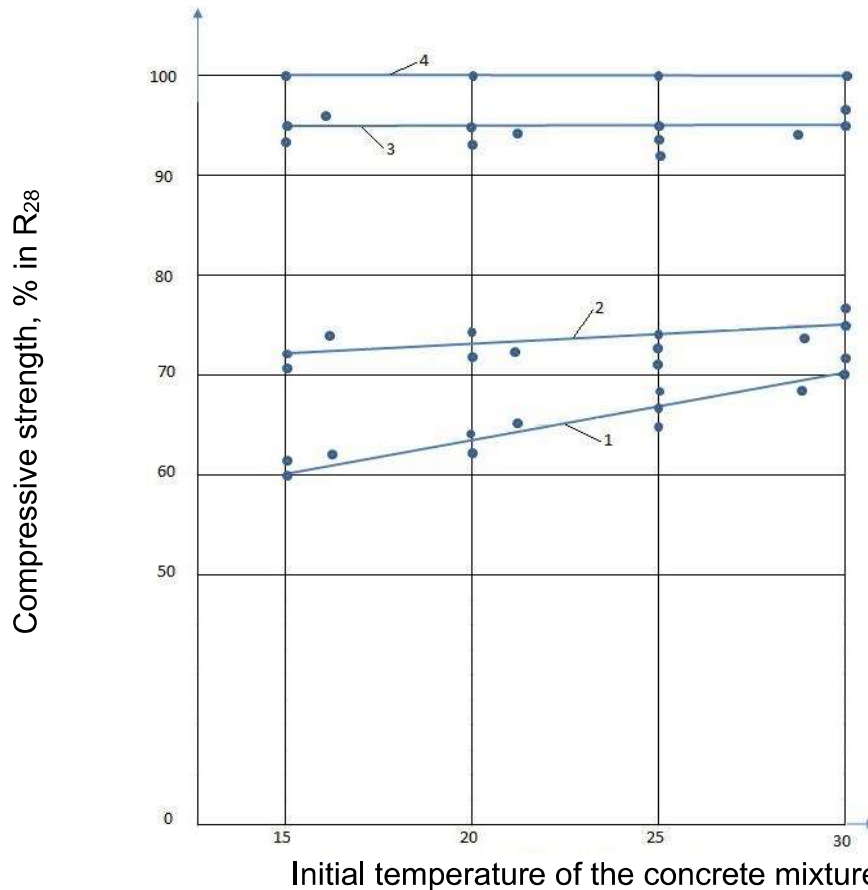


Figure 1: The pattern of the growth in the strength of concrete on Portland cement, depending on the initial temperature of the concrete mixture, which underwent heat treatment according to the mode of 2+3+6+4 hours

- 1) concrete strength 4 hours after heat and moisture treatment; 2) also, after 3 days; 3) also after 28 days; 4) also after 28 days of normal hardening.

Holding the concrete before heat treatment at a low temperature promotes a greater dissolution of silicate phases [2] and the formation of a smaller number of nucleating crystals but with a well-ordered structure and a high degree of solution saturation [13].

Thus, preliminary curing of concrete on portland cement at a relatively high ambient temperature, on the one hand, leads to a reduction in the preliminary curing time, an increase in the strength of concrete immediately after heat and moisture treatment, on the other hand, slowing down the further hydration of portland cement after heat and moisture treatment.

From table 1. It can be seen that for series 1 and 10, the heating mode, the

temperature of isothermal holding and the duration of heat and moisture treatment are the same, but the strength indicators after heat and moisture treatment are different. In this case, the difference in strength indicators can be explained by the degree of maturity of the concrete, since its initial temperature was different and the heating time to the isothermal holding temperature was different.

Concrete with an initial temperature of 30 °C (series 10) is heated to the isothermal holding temperature for 4 hours, and with an initial temperature of 15 °C (series 1) for 5.5 hours. Accordingly, by the 4th hour of heat and humidity treatment, the number of degree-hours is 272 (series 10) and 162 (series 1).

As a result, by the end of the heat and moisture treatment, concrete with an increased initial temperature gains a large amount of degree-hours (series 10) compared to concrete with a lower initial temperature (series 1) and, accordingly, the strength indicators are 70 and 61% of R_{28nt} .

It should be noted that an increase in the initial temperature of the concrete mixture from 15 to 30 °C did not lead to a significant increase in the strength of concrete after heat treatment with portland slag cement (Table 2). This is apparently due to the property of the slag, which at relatively low positive temperatures does not show activity in the process of hydration. The unacceptability of slag portland cement for the preparation of warm concrete is also indicated in [14].

The difference between portland slag cement concrete in comparison with portland cement concrete is that the 28-day strength of portland slag cement concrete after heat and moisture treatment for all series of experiments exceeds the strength of the same concrete hardened under normal conditions (Table 2) by 10-20%. The data obtained are fully consistent with the results of [1], which notes that a high heating temperature (80-90 °C) not only provides high concrete strength immediately after heating, but also does not reduce further intensive growth of concrete strength on slag Portland cement.

From the test results (Tables 1 and 2) it can be seen that the pattern of cooling significantly affects the strength of concrete after heat and moisture treatment. Concrete on portland cement with heat treatment modes $2 + 3 + 4 + 4 = 13$ h (series 4, table 1) and $2 + 3 + 2 + 6^* = 13$ hours (series 6 and 7, table 1) after heat and moisture treatment gain almost the same strength.

A similar effect is observed for concretes prepared on slag portland cement (series 4 and 6, Table 2). Equal strength indicators of concrete with

different isothermal holding times are explained, apparently, by the same degree of maturity. For example, concrete heated according to the 2 + 3 + 6 + 4 hours mode by the end of heat treatment gains the sum of degree-hours equal to 880; the same amount of degree-hours is gained by concrete subjected to heat treatment according to the 2 + 3 + 4 + 6 * hours mode. The total duration of heat treatment in both cases is the same and amounts to 15 hours. But in the second variant, the isothermal holding time is reduced by 2 hours.

From the above, it follows that the increased temperature of the external environment has a beneficial effect on the individual stages of heat and moisture treatment. With an increase in the ambient temperature, the initial temperature of the concrete mix increases, which, at the same rate of temperature rise, contributes to a reduction in the time of this stage in comparison with concrete having a lower initial temperature. Cooling of concrete occurs more slowly due to a decrease in the temperature gradient between concrete and the environment, thereby it becomes possible to reduce the isothermal holding time.

Thermal holding of products after a short isothermal holding can be used especially effectively in hot climates. The increased temperature of the medium reduces heat loss through the enclosing structures of the chambers due to a decrease in the temperature gradient, providing a slower cooling of the products in the chamber. On the other hand, conditions are created for cooling products directly on the operating areas of the shops.

It is advisable to carry out heat and moisture treatment with thermos cooling (two-stage heat and moisture treatment) of products according to two options, depending on the form of labor organization at precast concrete enterprises.

Table 2.

Strength of concrete on slagportland cement under different modes of heat and moisture treatment

Options	№ Series	Environment parameters in the chamber during preliminary exposure		Initial temperature of concrete mix $T_{c.m.}, ^\circ\text{C}$	V / C	Cone draft, sm	Steaming mode, hour	Compressive strength of concrete, MPa through			
		t, $^\circ\text{C}$	φ , %					4 hours after TBO	3 days	28 days	28 days normal hardening
1	2	3	4	5	6	7	8	9	10	11	12
I	1	15-16	70-75	15	0,6 5	3-3,5	2+3+8+4	<u>11,4</u> 70	<u>13,2</u> 81	<u>19,6</u> 120	<u>16,3</u> 100
	2	20-21	70-75	20	0,6 5	3-3,5	2+3+6+4	<u>9,6</u> 63	<u>11,8</u> 77	<u>18,0</u> 118	<u>15,2</u> 100
II	3	26-28	48-50	22-25	0,6 5	3-3,5	2+3+4+4	<u>9,3</u> 60	<u>11,0</u> 71	<u>16,8</u> 108	<u>15,5</u> 100
	4	26-28	48-50	22-25	0,6 5	3-3,5	2+3+6+4	<u>9,5</u> 65	<u>12,1</u> 83	<u>17,1</u> 117	<u>14,6</u> 100
	5	26-28	48-50	22-25	0,6 5	3-3,5	2+3+8+4	<u>12,5</u> 72	<u>14,5</u> 84	<u>20,7</u> 10	<u>17,2</u> 100
	6	26-28	48-50	22-25	0,6 5	3-3,5	2+3+4+6*	<u>10,07</u> 65	<u>12,5</u> 81	<u>18,4</u> 119	<u>15,4</u> 100
	7	26-28	48-50	22-25	0,6 5	3-3,5	2+3+6+4	<u>10,1</u> 65	<u>12,5</u> 81	<u>17,5</u> 113	<u>15,5</u> 100
III	8	32-34	44-46	28-30	0,6 5	2,5-3	2+3+8+4	<u>12,5</u> 71	<u>14,4</u> 82	<u>20,0</u> 114	<u>17,6</u> 100
	9	32-34	44-46	28-30	0,6 5	2,5-3	2+3+6+4	<u>10,6</u> 67	<u>13,6</u> 87	<u>19,0</u> 121	<u>15,6</u> 100
	10	32-34	44-46	28-30	0,6 5	2,5-3	2+3+4+4	<u>9,5</u> 61	<u>11,3</u> 72	<u>17,1</u> 109	<u>15,6</u> 100

*Notes. one). Above the line - concrete strength, MPa, below the line -% 2). 6 * Cooling of concrete at an average rate of 3-4 $^\circ\text{C}$ / hour for 6 hours is carried out with an open regulating gate of the ventilation duct of the chamber. 3). Concrete in series 1 and 2 are prepared without water heating, i.e. according to the usual technology and pre-conditioned in the shop for 2 hours under the conditions indicated in the table.*

If the molding equipment and heating units are assigned to the shift crew, it is advisable to cool the products in the heat and moisture treatment chambers. In the conditions of two-, three-shift operation, thermos cooling of products after isothermal holding is recommended to be carried out in ripening chambers, since in this case enterprises are interested in increasing the turnover of molding equipment and thermal units.

The expediency of a two-stage heat and humidity treatment for the production of products in areas with hot climates was noted in [15, 16, 17, 18, 19, 20].

Thus, the results of experimental studies prove the correctness of the assumptions on reducing the time of isothermal holding in the process of heat and moisture treatment of concrete in a hot climate. The purpose of the modes of heat and moisture treatment for each specific case, depending on the initial temperature of concrete and the environment, requires a special study. This is a laborious process, takes considerable time and is extremely inconvenient (and in many cases generally unacceptable) for production workers.

Therefore, we proposed an analytical method for optimizing the aging modes of

products during heat treatment, taking into account the temperature of the environment, which is as follows.

The sum of degree - hours is determined for the accepted factory mode, where the temperature of the concrete mixture (t_{c1}) entering the heat treatment unit, according to the current standards, is $+ 15^{\circ}\text{C}$:

$$S_1 = (t_{is} - t_{c1}) (\tau_{lif}^1 / 2 + \tau_{is}^1), \text{ deg-hour};$$

Then the sum of the degree-hours of the same mode is determined, but with the actual initial temperature of the concrete (t_{c2}):

$$S_2 = (t_{is} - t_{c2}) (\tau_{lif}^2 / 2 + \tau_{is}^2), \text{ deg-hour};$$

The ratio of the latter to the former is the optimization factor:

$$K_{op} = S_2 / S_1;$$

The duration of the active cycle of heat and moisture treatment of concrete, taking into account K_{op} :

$$T_{op} = T_1 \cdot K_{op} = (\tau_{lif}^1 + \tau_{is}^1) \cdot K_{op}, \text{ hour}$$

The results of studying the modes of heat and moisture treatment of concrete with different initial temperatures of the concrete mixture and the obtained strength indicators of concrete after heat and moisture treatment confirmed the correctness of the proposed method for optimizing the modes of heat and moisture treatment in the manufacture of precast concrete products in hot climates.

Conclusion. An increased initial temperature ($25 \dots 30^{\circ}\text{C}$) before heat treatment contributes to a more intensive increase in the strength of concretes during heat and moisture treatment, prepared with Portland cement. For concretes on slag portland cement, it has no noticeable effect.

The strength of concrete prepared on portland cement and slag portland cement is significantly influenced by the nature of cooling; cooling at an elevated temperature ($35-40^{\circ}\text{C}$) of the environment proceeds more slowly, reduces temperature gradients in the product, contributes to an increase in the strength of concrete immediately after heat and moisture treatment.

The increased temperature of the environment makes suitable conditions for two-stage heat and moisture treatment. This method is equally effective for concretes based on portland cement and portland slag cement.

The purpose of the modes of heat and humidity treatment of precast concrete products, taking into account the ambient temperature of a hot climate, makes it possible to reduce the active cycle time (temperature rise + isothermal heating) by $2 \dots 3$ hours. The decrease in energy consumption is $20 \dots 22\%$.

References

- [1] Mironov S.A. Temperature factor in concrete hardening. -M.: Stroyizdat, 1948. - 236 p.
- [2] Mironov S.A., Malinina L.A. Acceleration of concrete hardening. - M.: Stroyizdat, 1961. - 224 p.
- [3] Malinina L.A. Heat and humidity treatment of heavy concrete. Moscow: Stroyizdat, 1977.- 159 p.
- [4] Kaiser L.A. Kinetics of hardening of Portland cement under steaming conditions // Trudy RILEM. - M.: Stroyizdat, 1964.-22 p.
- [5] Royak S.M., Cherkasova A.F., Yashina E.G. Influence of heat and moisture treatment on hardening of slag Portland cement // Trudy RILEM. - M.: Stroyizdat, 1964.- 21 p.
- [6] Investigation of the processes of hydration of Portland cement during heat and moisture treatment at temperatures up to 1000°C / PP Budnikov, SM Royak, Yu.S. Malinin, MM Mayants // Truda RILEM. - M.: Stroyizdat, 1964.- 24 p.

- [7] Hydration processes during accelerated hardening of cement / TM Berkovich, DM Haiker, OI Gracheva et al. // Proceedings of RILEM. - M.: Stroyizdat, 1964.- 16 p.
- [8] Sheikin A.E., Oleinikova N.I. Influence of heat and moisture treatment and fineness of cement grinding on the structure and properties of cement stone // Trudy RILEM. - M.: Stroyizdat, 1964. – 24s.
- [9] Josef Riha. Ways to maximum reduction of concrete hardening time / Proceedings of RILEM. - M.: Stroyizdat, 1964. –14 p.
- [10] Soroker V.I. Two-stage hardening of concrete and rational consumption of cement - ways to increase the turnover rate of forms in reinforced concrete factories // Trudy RILEM. - M.: Stroyizdat, 1964. -9p.
- [11] Stupakov G.I. Acceleration of concrete hardening under the influence of high summer temperatures in the conditions of Central Asia // Trudy RILEM. - M.: Stroyizdat, 1964.-5p.
- [12] Krylov B.A. Principles of optimal concreting technology // Sb.tr. - Vladimir, 1985- Concreting with continuous vibroelectric heating of the mixture. - S. 12-15.
- [13] Volzhensky A.V., Chistov Yu.D., Garashin V.R. Influence of the hardening temperature on the properties of Portland cement // Cement.-1969. -№8. -FROM. 3-5.
- [14] Reinsdorf Z. Acceleration of concrete hardening by heating freshly made concrete mixture (warm concrete). Trudy RILEM. –M.: Stroyizdat, 1964. -15s.
- [15] Krylov B.A. Domestic and foreign experience of economical consumption of fuel and energy resources in the production of prefabricated reinforced concrete // Ways to further reduce heat and power costs in the manufacture of precast concrete. –M.: MDNTP. -1988. -FROM. 3-13.
- [16] Krylov B.A. ways to save energy costs in the production of precast concrete products // ways to reduce energy costs in the precast concrete industry. –M.: MDNTP. 1981. –S. 3-12.
- [17] Rakhimov A.M., Zhuraev B.G., Khakimov Sh.A. An energy-saving method of heat treatment of concrete in hot climates. International scientific journal ISSN 2410-700X. "Symbol of Science". No. 4/2016 Part 3. Russia, Ufa. -FROM. 63-65.
- [18] Rakhimov A.M., Khusainov M.A. Sh.Turgunov Stability of concrete on Portland cement and glas Portland cement (GPC) under selected preparation modes. // Materiais da vi conferenciainternacional de investigacao e praticaciencia, Engenharia e tecnologia 4 de julho 2019 Sao paulo, Brazil. "Ciencia, Engtnharia E Tecnologia" №4/2019. Sao Paulo 2019. Publicado por Science WA LTD. BRASIL. 33-39 pp.
- [19] Khusainov M.A. Rakhimov A.M. Strength characteristics of stress-cement concrete (NC) during heat treatment in a bubble-type chamber. // International Journal of Progressive Sciences and Technologies (IJPSAT) ISSN: 2509-0119 Vol. 27 No. 1 Junio 2021 y. 131-136 pp.
- [20] Rakhimov A.M. Acceleration of concrete hardening. Monograph. - Tashkent; publishing house of Lesson press, 2019. 148 ps.
- [21] Khusainov M.A. (2020) Scientific-technical journal (STJ FerPI, Vol.24, (2) pp. 256-259)

C O N T E N T S

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

A.Shodmonkulov, R.Jamolov, X.Yuldashev	
Analysis of load changes in the chain drive during the drying process of cotton falling from the longitudinal shelves of the drum.....	3
A.Xomidjonov	
Influence and characteristics of drying mechanisms in leather production on the derma layer.....	8
J.Monnopov, J.Kayumov, N.Maksudov	
Analysis of elastic fabrics for compression sportswear in the new assortment	13
S.Matismailov, K.Matmuratova, Sh.Korabayev, A.Yuldashev	
Investigation of the influence of speed modes of the combined drum on the quality indicators of the tape.....	18
A.Shodmonkulov, K.Jumaniyazov, R.Jamolov, X.Yuldashev	
Determination of the geometric and kinematic parameters of the developed chain gear for the 2SB-10 dryer.....	23
R.Jamolov, A.Shodmonkulov, X.Yuldashev	
Determination of dryer drum moisture extraction depending on its operating modes.....	27
A.Djuraev, K.Yuldashev, O.Teshaboyev	
Theoretical studies on screw conveyor for transportation and cleaning of linter and design of constructive parameters of transmissions.....	29
S.Khashimov, Kh.Isakhanov, R.Muradov	
Creation of technology and equipment for improved cleaning of cotton from small impurities.....	36
G.Juraeva, R.Muradov	
The process of technical grades of medium staple cotton at gin factories and its analysis.....	40
I.Xakimjonov	
Literature analysis on the research and development of the method of designing special clothes for workers of metal casting and metal processing enterprises.....	44
GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES	
A.Khodjiev, A.Choriev, U.Raximov	
Improving the technology of production of functional nutrition juices.....	49
U.Nishonov	
Research in beverage technology intended to support the functions of the cardiovascular system.....	53

Z.Vokkosov, S.Hakimov	
Development of new types of vegetable juices and beverages technology...	59
CHEMICAL TECHNOLOGIES	
M.Latipova	
Analysis of the current status of thermoelectric materials and technology for obtaining and manufacturing half-elements.....	66
G.Ochilov, I.Boymatov, N.Ganiyeva	
Physico-chemical properties of activated adsorbents based on logan bentonite.....	72
U.Nigmatov	
Simulation of heat transfer process in absorber channels.....	77
T.Abduxakimov, D.Sherkuziev	
Procurement of local raw materials complex fertilizers with nitrogen-phosphate-potassium containing moisture.....	84
P.Tojiyev, X.Turaev, G.Nuraliyev, A.Djalilov	
Study of the structure and properties of polyvinyl chloride filled with bazalt mineral.....	89
M.Yusupov	
Investigation of phthalocyanine diamidophosphate- copper by thermal analysis.....	95
L.Oripova, P.Xayitov, A.Xudayberdiyev	
Testing new activated coals AU-T and AU-K from local raw materials when filtration of the waste mdea at gazlin gas processing plant.....	101
N.Kurbanov, D.Rozikova	
Based on energy efficient parameters of fruit drying chamber devices for small enterprises.....	107
Sh.Xakimov, M.Komoliddinov	
Basic methods and technological schemes for obtaining vegetable oils.....	113
A.Boimirzaev, Z.Kamolov	
Size-exclusion chromatography of some polysaccharide derivatives from natural sources.....	117
MECHANICS AND ENGINEERING	
U.Erkaboev, N.Sayidov	
Dependence of the two-dimensional combined density of states on the absorbing photon energy in GaAs/AlGaAs at quantizing magnetic field.....	124
I.Siddikov, A.Denmumaxamadiyev, S.A'zamov	
Investigation of electromagnetic current transformer performance characteristics for measuring and controlling the reactive power dissipation of a short-circuited rotor synchronous motor.....	136
Sh.Kudratov	
Evaluation and development of diagnostics of the crankshaft of diesel locomotives.....	141

Z.Khudoykulov, I.Rakhmatullaev	
A new key stream encryption algorithm and its cryptanalysis.....	146
T.Mominov, D.Yuldoshev	
Coordination of the movement of transport types in areas with high passenger flow.....	157
R.Abdullayev, M.Azambayev, S.Baxritdinov	
Analysis of research results according to international standards.....	163
R.Abdullayev, M.Azambayev	
Cotton fiber rating, innovation current developments, prospects for cooperation of farms and clusters.....	168
F.Dustova, S.Babadzhanov.	
Calculation of the load on the friction clutch of the sewing machine.....	174
Z.Vafayeva, J.Matyakubova, M.Mansurova	
Improvement of the design of the shuttle drum in the sewing machine.....	179
A.Obidov, M.Vokhidov	
Preparation of a new structure created for sorting of ginning seeds.....	185
Sh.Mamajanov	
Carrying out theoretical studies of the cotton regenerator.....	192
ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION	
A.Khojaev	
Methodological issues of organizing internal audits and control of off-budget funds in higher education institutions.....	199
I.Nosirov	
Theoretical foundations of establishing new technologies on personal management system.....	203
Z.Mamakhanova, D.Ormonova	
Specific characteristics of uzbek national art of embroidery.....	209
A.Raximov, M.Khusainov, M.Turgunpulatov, S.Khusainov, A.Gaybullayev	
Energy-saving modes of the heat treatment of concrete.....	213
ECONOMICAL SCIENCES	
M.Bekmirzayev, J.Xolikov	
Prospects for the development of service industries.....	222
A.Ilyosov	
Organizational and economic mechanisms to support the export of industrial products: a comparative analysis of foreign experience and proposals.....	227
I.Foziljonov	
The importance of multiplier indicators in assessing the effectiveness of the cash flow of the enterprise.....	232
K.Kurpayanidi	
Innovative activity of business entities in the conditions of transformation: a retrospective analysis.....	238

Sh.Muxitdinov	
Main characteristics of the risk management mechanism in manufacturing enterprises.....	248
Y.Najmiddinov	
Green economy and green growth. initial efforts of sustainable development in Uzbekistan.....	252
E.Narzullayev	
The methods for measuring the effectiveness of social entrepreneurship activity.....	259
E.Narzullayev	
Analysis of the management and development of environmental social entrepreneurship in Uzbekistan.....	265
F.Bayboboeva	
Legal regulation of entrepreneurial activity.....	270
Z.Boltaeva	
Foundations of neuromarketing strategy in industry.....	276
R.Rashidov	
Issues of regional development of small business.....	281
Sh.Abdumurotov	
Methodology for forecasting the competitiveness of an enterprise based on the Elliott wave principle.....	288
S.Goyipnazarov	
Assessment of impact of artificial intelligence on labor market and human capital.....	299
A.Norov	
Evolution of management science.....	307
K.Narzullayev	
Investment process in the republic of Uzbekistan.....	317
Kh.Irismatov	
Statistical analysis of assessment of the volume of the hidden economy in the republic of Uzbekistan.....	322
