

DOI: <https://doi.org/10.54338/18294200-2026.2-09>**MODELING AND INFORMATION TECHNOLOGIES IN CONSTRUCTION****THE MAIN ISSUES OF CHOOSING EFFECTIVE CONCRETE CURING METHODS AND PROVIDING INFORMATION ON THEIR IMPLEMENTATION****Armine Ghulyan*, Robert Noramiryan, Xachik Kirakosyan, Artur Manukyan***National University of Architecture and Construction of Armenia, Yerevan, RA***ghulyanarmine@mail.ru*

Improving the concrete curing and reinforced concrete structures has an important meaning in ensuring their physical and mechanical properties by design. Concrete curing measures aimed at controlling temperature and humidity ensure that sufficient water is available for concrete to achieve its desired properties. The advantages and disadvantages of existing methods of concrete curing in the climatic conditions of the Republic of Armenia are presented. Based on statistical analyses and scientific experiments, effective concrete curing schemes, technological process schedules, and technical means of automation are proposed.

Keywords: Concrete, curing, watering, efficiency, experiments, analysis

Introduction

The use of monolithic concrete in the construction industry has reached unprecedented volumes both worldwide and in the Republic of Armenia, and the quality of construction structures made from it can greatly affect the operational properties, cause a reduction in the service life of structures, and in some cases even collapse.

It is a well-known fact that freshly placed concrete requires systematic curing in certain climatic conditions, but how this curing should be carried out in the conditions of a specific construction object is not clearly defined.

Scientific and regulatory sources [1-6] indicate general parameters for concrete curing, but their practical application requires the implementation of separate studies in specific cases, which, as a rule, is not done. In particular, the codes [6] state that concrete curing should ensure the prevention of moisture evaporation and for this purpose, appropriate measures should be indicated in the Construction Management Project (CMP), which will ensure the normal hardening of concrete and the achievement of the indicators specified in the project. If the CMP is considered to be a mandatory document in the design of facilities in the Republic of Armenia, then the development of the Project of Work Production (PWP) is not mandatory, therefore, in most cases it is not developed. It turns out that construction organizations arbitrarily choose the method of concrete curing, for example, in dry and hot conditions they mainly carry out direct soaking of the concrete surface with a hose even before the construction achieves a strength of 2,5 MPa, when movement on the concrete surface is not allowed by the codes [6]. The same codes generally prohibit direct soaking of the concrete surface.

The design and construction of construction objects on the BIM platform implies a certain automation of processes, the inadmissibility of arbitrary decision-making by individuals, therefore, the development of guidelines for the implementation of construction processes, including concrete curing, is important, which is the problem of this research.

Materials and Methods

Concrete curing is a multifactorial process that includes measures carried out both in winter conditions and in dry and hot conditions. The research partially studied the methods of concrete curing in winter conditions in the Republic of Armenia, which include the electric heating of concrete with wires wrapped around the structure. The mentioned method has relatively more clearly developed guidelines with the indication of parameters.

The main problems of this research relate to the curing of concrete in dry and hot conditions.

Dry and hot climatic conditions of concreting refer to the period when the average monthly air temperature is above 25°C and the humidity is below 50 % [6].

The main research questions were:

- Comparative analysis of existing concrete curing methods in dry and hot climates, selection of the most effective methods,
- Determining the type, quantity, and arrangement of irrigation devices for selected seasons,
- Calculation of water consumption volumes and determination of intensity for watering concrete,
- Development of standard watering schedules (regimes),
- Planning experiments for different irrigation regimes,
- Conducting experiments,
- Analysis of experimental results and implementation of conclusions,
- Determination of average concrete maintenance periods in the capital of Armenia, Yerevan, based on the analysis of meteorological data for 2020-2024.

The results of a comparative analysis of existing concrete watering methods are presented in Table 1.

Table 1

Basic methods of concrete curing in dry and hot conditions

Watering method	Scope of application	Disadvantages	Advantages	Applicability in the Republic of Armenia
Ponding Method	Flat surfaces (slabs, floors)	Application only for horizontal surfaces, water evaporation in hot weather conditions, large water reserves required	Maintaining constant humidity, easy to implement, ensuring temperature stability, low labor intensity	Rarely applicable
Watering method including intensive precipitation	Vertical, horizontal surfaces, large-scale constructions	Dependence on weather conditions, uneven humidification, high labor intensity	Suitable for any surface, easy to use, automation possible	Most applicable, mainly with the use of shower heads
Wet Covering method	Vertical, horizontal, inclined surfaces	Periodic monitoring (prevention of moisture loss), not applicable in hard-to-reach places	Low risk of thermal cracking, suitable for vertical surfaces	Rarely applicable
Spraying or Fogging method	Vertical, horizontal, various surfaces	Use of special equipment, reduction of efficiency under the influence of wind	Convenience for large areas, automation possible	Not applicable
Chemical compounds method	Vertical, horizontal, various surfaces	Cost, application safety features, environmental pollution	Time saving, water saving, easy to implement, long-lasting effect	Used in rare cases

Taking into account the inadmissibility of direct surface watering as defined by the standards and the possibilities of automating the watering process, calculations of watering parameters and tests of concrete samples were performed for the sprinkling and fine-dispersion methods, with the former considering the spray and intensive rain (sprinkler) methods. These are excellent methods of curing when the ambient temperature is well above freezing and the humidity is low [7].

Considering the high workload of uniform calculations (determination of water consumption for about 100 cases of air temperature conditions of 25°C, 30°C, 35°C and relative humidity of air of 0...100 % for selected irrigation schemes), the calculations were carried out using the capabilities of artificial intelligence. The intensive precipitation method was used for a conventional 18 m x 30 m roof slab, on which the arrangement of sprinklers was selected according to the following scheme (Fig. 1):

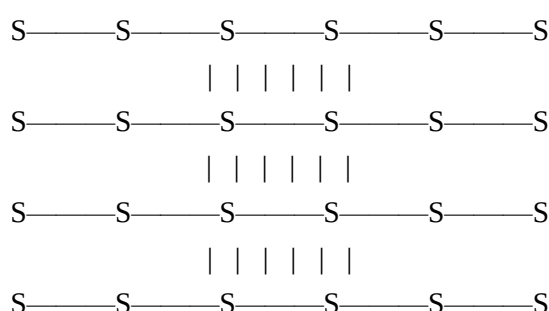


Fig. 1. The sprinklers layout on the slab for intensive precipitation method

In the case of the fine dispersion method, the number of rows was increased by 1 in both directions, i.e. the number of devices was taken as 35.

To avoid random errors and ensure the uniformity of parameters, recalculations were made for the specified intensity, so that in case of automation, the practical application of the modes would be easier.

A strip foundation with a width of 0,6 m and a total length of 192 m was considered for edge irrigation.

Results and Discussion

Based on the data obtained, water consumption graphs were compiled for different cases, which are presented below (Fig. 2-4).

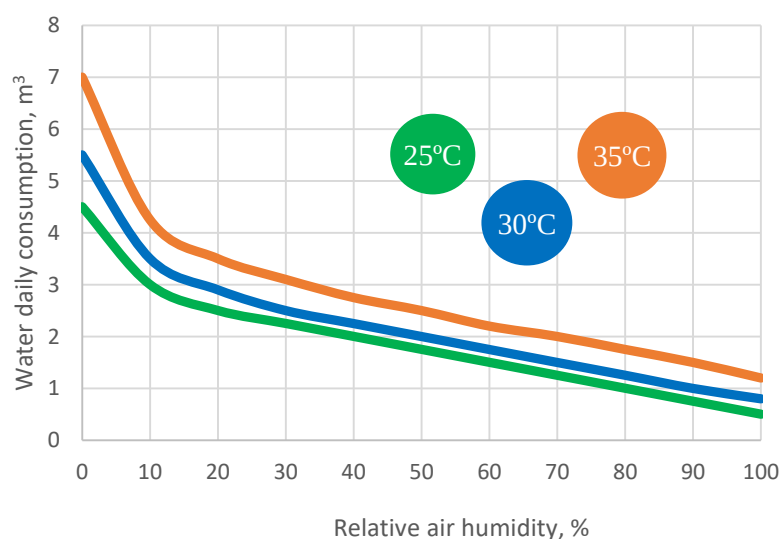


Fig. 2. Graph of calculated water consumption for irrigation of reinforced concrete foundations by hose with shower head for the average air temperatures of 25 °C, 30 °C and 35 °C

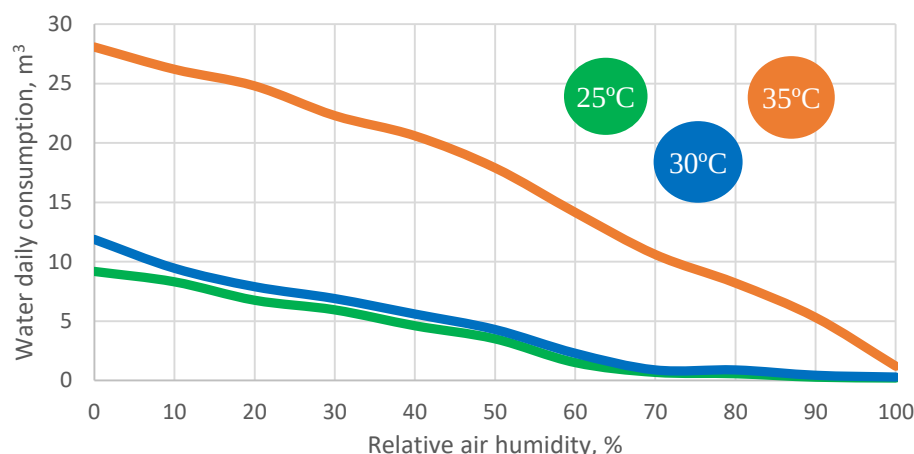


Fig. 3. Graph of calculated water consumption for irrigation of reinforced concrete slabs by the method of intensive precipitation for the average air temperatures of 25°C, 30°C and 35°C

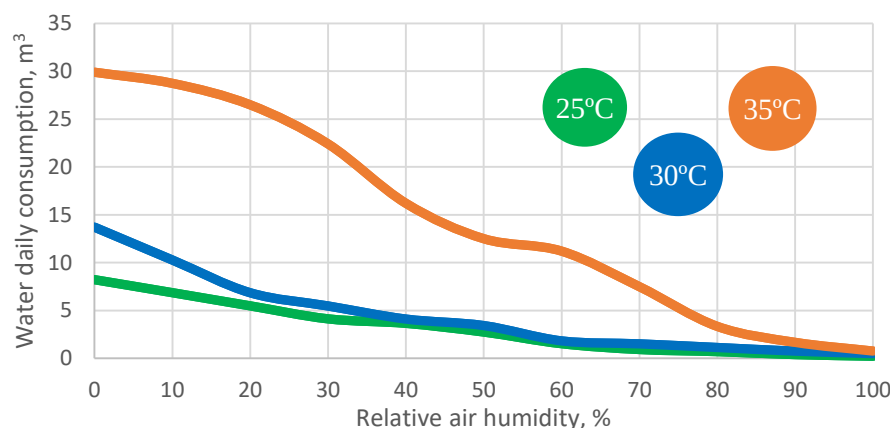


Fig. 4. Graph of calculated water consumption for irrigation of reinforced concrete slabs by the method of spraying (fogging by micro-sprinkler) for the average air temperatures of 25°C, 30°C and 35°C

Using artificial intelligence capabilities, typical schedules have been created for the graphs. In particular, the schedule presented in Table 2 has been created for the intensive precipitation season.

The analysis of the presented graphs (Fig.2-4) shows that in the case of intensive precipitation and spraying methods, a sharp increase in water consumption is observed at a temperature of 35 °C. The daily water consumption for a 18 m x 30 m cover slab increases at low humidity values to a maximum of 28 m³ in the case of intensive precipitation and up to 30 m³ in the case of spraying methods. The maximum consumptions for 1 m³ of cover slab will be 0,25 m³/day and 0,33 m³/day, respectively. At average values of humidity and temperature 30°C, water consumption will be about 0,049 m³/day in both cases, which exceeds the average values in the codes set in the 1980s by 1,5 times (0,034 m³/day).

The mentioned increase is significant, but it should be noted that when using the above methods, the level of dust on the construction site decreases, a favorable working microclimate is created

Table 2

18 x 30 m concrete covering slabs in intensive precipitation maintenance schedules

At an average daily air temperature of 25 °C									
Relative air humid, (%)	Number and times of watering during the day						Number of waterings per day	Watering intensity, (l/s)	Daily water consumpt, (m³)
	I	II	III	IV	V	VI			
0	06:00 – 06:18	09:00 – 09:18	12:00 – 12:20	15:00 – 15:18	18:00 – 18:18	21:00 – 21:18	6	1,5	9,18
10	06:00 – 06:15	09:00 – 09:15	12:00 – 12:20	15:00 – 15:15	18:00 – 18:15	21:00 – 21:12	6		8,30
20	06:00 – 06:12	09:00 – 09:12	12:00 – 12:15	15:00 – 15:12	18:00 – 18:12	21:00 – 21:12	6		6,75
30	09:00 – 09:15	12:00 – 12:12	15:00 – 15:15	18:00 – 18:12	21:00 – 21:12	–	5		5,94
40	09:00 – 09:10	12:00 – 12:10	15:00 – 15:14	18:00 – 18:10	21:00 – 21:10	–	5		4,85
50	09:00 – 09:08	12:00 – 12:08	15:00 – 15:10	18:00 – 18:08	21:00 – 21:09	–	5		3,87
60	09:00 – 09:02	13:00 – 13:02	17:00 – 17:02	21:00 – 21:02	–	–	4		0,72
70	06:00 – 06:03	12:00 – 12:02	18:00 – 18:02	–	–	–	3		0,68
80	06:00 – 06:03	18:00 – 18:03	–	–	–	–	2		0,56
90	06:00 – 06:03	–	–	–	–	–	1		0,27
At an average daily air temperature of 30 °C									
Relative air humid, (%)	Number and times of watering during the day						Number of waterings per day	Watering intensity, (l/s)	Daily water consumpt, (m³)
	I	II	III	IV	V	VI			
0	06:00 – 06:20	09:00 – 09:20	12:00 – 12:30	15:00 – 15:20	18:00 – 18:30	21:00 – 21:15	6	1,5	11,88
10	06:00 – 06:15	09:00 – 09:15	12:00 – 12:25	15:00 – 15:15	18:00 – 18:25	21:00 – 21:10	6		9,45
20	06:00 – 06:12	09:00 – 09:12	12:00 – 12:20	15:00 – 15:12	18:00 – 18:20	21:00 – 21:10	6		7,74
30	06:00 – 06:15	09:00 – 09:12	12:00 – 12:15	15:00 – 15:12	18:00 – 18:10	21:00 – 21:10	6		6,84
40	06:00 – 06:15	09:00 – 09:10	12:00 – 12:10	15:00 – 15:05	18:00 – 18:10	21:00 – 21:10	6		5,38
50	09:00 – 09:10	12:00 – 12:10	15:00 – 15:10	18:00 – 18:05	21:00 – 21:10	–	5		4,05
60	06:00 – 06:05	12:00 – 12:05	18:00 – 18:05	–	–	–	3		1,35
70	06:00 – 06:05	18:00 – 18:05	–	–	–	–	2		0,90
80	06:00 – 06:05	8:00 – 18:05	–	–	–	–	1		0,90
90	06:00 – 06:05	–	–	–	–	–	1		0,45

Table 2

18 x 30 m concrete covering slabs in intensive precipitation maintenance schedules (Continuation)

At an average daily air temperature of 35 °C															
Number and times of watering during the day													Number of waterings per day	Watering intensity, (l/s)	Daily water consumpt, (m³)
Relative air humid, (%)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
0	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	00:00	02:00	04:00	12	1,5	28,08
	—	—	—	—	—	—	—	—	—	—	—	—			
10	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	00:00	02:00	04:20	11		25,74
	—	—	—	—	—	—	—	—	—	—	—	—			
20	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00	00:00	02:00	—	11		25,74
	—	—	—	—	—	—	—	—	—	—	—	—			
30	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	23:00	02:00	—	—	10		23,40
	—	—	—	—	—	—	—	—	—	—	—	—			
40	06:00	08:00	10:00	12:00	14:00	16:00	18:00	20:00	23:00	02:00	—	—	10		23,40
	—	—	—	—	—	—	—	—	—	—	—	—			
50	06:00	09:00	12:00	15:00	18:00	21:00	00:00	03:00	—	—	—	—	8		18,73
	—	—	—	—	—	—	—	—	—	—	—	—			
60	06:00	10:00	14:00	18:00	22:00	02:00	—	—	—	—	—	—	6		14,15
	—	—	—	—	—	—	—	—	—	—	—	—			
70	06:00	11:00	16:00	21:00	02:00	—	—	—	—	—	—	—	5		11,70
	—	—	—	—	—	—	—	—	—	—	—	—			
80	06:00	12:00	18:00	00:00	—	—	—	—	—	—	—	—	4		9,36
	—	—	—	—	—	—	—	—	—	—	—	—			
90	06:00	13:00	20:00	—	—	—	—	—	—	—	—	—	3		7,02
	—	—	—	—	—	—	—	—	—	—	—	—			

So, based on the analysis of water consumption, it is possible to consider the intensive precipitation method for watering the cover slabs as effective, and for watering the strip foundations, watering using hose with shower head or installing perforated rubber pipes on the cover, ensuring water supply in an automated mode. The latter method provides constant moistening and a “soft” effect on the concrete surface.

The use of perforated pipes made of rubber or other materials is also possible for watering of formwork-removed reinforced concrete walls (diaphragms). It is advisable to water the side and bottom surfaces of formwork-removed columns and beams using hoses with shower heads, as needed, within 7 days after formwork removal.

To substantiate the feasibility of watering reinforced concrete foundations by intensive precipitation and shower heads laboratory tests of the strength of concrete samples were carried out according to the schedule presented in Fig. 5.

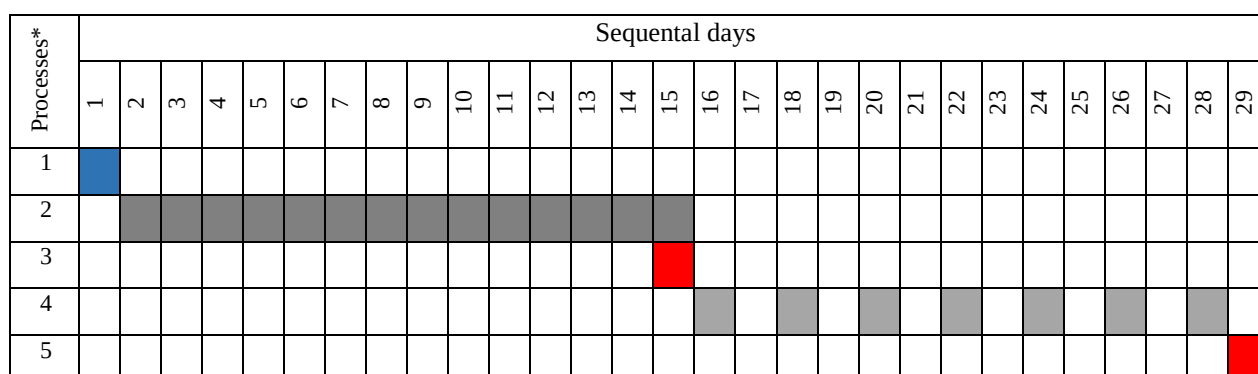


Fig. 5. Comparison of calculated water consumption graphs for curing of reinforced concrete slabs by spraying method
**1 – sample filling, condensation, 3, 5 – sample testing*
2, 4 – specimen curing / humidification /

The number of 100mm x 100mm x 100mm concrete cube samples subjected to compressive strength tests, the curing method, and the test results are given below in Table 3.

Table 3

Description of the tested concrete samples and test results

Serial number	The code	Curing method	Test date	Compressive strength, MPa	Average mass, g
1	1-1	Intensive precipitation	15.08.2025	30,2	2385,8
2	1-2				
3	1-3				
4	1-4		29.08.2025	35,5	2379,8
5	1-5				
6	1-6				
7	2-1	Spraying or fogging by micro-sprinkler irrigation	15.08.2025	30,4	2365,0
8	2-2				
9	2-3				
10	2-4		29.08.2025	35,0	2360,0
11	2-5				
12	2-6				
13	3-1	Watering by hose with shower head	15.08.2025	32,0	2353,2
14	3-2				
15	3-3				
16	3-4		29.08.2025	34,2	2360,0
17	3-5				
18	3-6				
19	4-1	Storage in water at 20°C	15.08. 2025	28,0	2355,8
20	4-2		29.08.2025	30,2	
21	4-3	Not cured	15.08.2025	33,0	2348,0
22	4-4		29.08.2025	34,2	

The test results show that samples irrigated by intensive precipitation and spraying methods showed similar results: they achieved about 92 % of the design strength in 14 days and about 100 % in 28 days. Samples irrigated by hose with shower head achieved about 91 % of the design strength in 14 days, and about 99 % in 28 days. Paradoxically, the maximum compressive strength was demonstrated by the samples that were not cured, which achieved 102 % of the compressive strength in 14 days and 117% in 28 days, which has a logical explanation.

The water included in the composition of concrete contributes to sufficient hydration to achieve the desired properties of the concrete mortar, therefore, concrete curing measures are necessary to ensure the presence of this water until the desired properties are achieved [8, 9].

In the case of low water-cement values and low primary porosity of concrete, measures may be necessary to ensure the availability of additional water to fill the pores to assist hydration.

Both hydration water and gel water are required for the hydration of Portland cement. Cement hydration can only continue if there is sufficient water to support both the chemical reactions and to fill the pores of the gel (Neville, A.M. (1996), Properties of Concrete; Powers and Brownyard (1947), Studies of the Physical Properties of Hardened Portland Cement Paste; Young, J.F. and Mindess, S. (1981), Concrete. Prentice-Hall, New Jersey; Taylor, H.F.W. (1997), Cement Chemistry) indicate that the total amount of water required for cement hydration is 0,44 g of water per gram of cement, plus the water for setting that must be added to keep the capillary pores saturated.

In 1948, Powers demonstrated that at water-cement ratios below 0,5 and with low primary porosity, concrete treatment measures may be required to ensure that additional water is available to support hydration until the pores are saturated to a degree that will ensure that the concrete achieves its final properties. Powers confirmed that protection from evaporation alone is not sufficient; additional water introduction measures are required (The Powers Model (1948)). However, Powers also noted that not all mixtures with water-cement ratios below 0,5 require additional external water to achieve their full hydration potential [10, 11].

The paradoxical results of the tests in this study thus have an explanation. However, it should be noted that compressive strength is a volumetric indicator, and the external watering of concrete (with a penetration layer of about 2 cm) does not significantly affect the compressive strength, while such properties of concrete as wear resistance, water permeability, and corrosion resistance are largely dependent on external curing.

Visual inspection of the concrete samples showed that the untreated ones had a certain roughness of the upper surface, relatively large pores, which may indicate their self-drying.

Research indicates that one of the main problems of concretes with a low water-cement ratio is self-drying, i.e. internal drying due to water absorption during hydration (Neville, A.M. (1996), Properties of Concrete; Powers and Brownyard (1947), Studies of the Physical Properties of Hardened Portland Cement Paste; L. Parrott (1986), Measurement and Modeling of Porosity in Drying Cement Paste; Patel et al. (1988), Influence of curing at different relative humidities upon compound reactions and porosity in Portland cement paste; Spears (1983), The 80 Percent Solution to Inadequate Curing Problems).

During hydration, the internal water content becomes insufficient and low water-cement ratio mixtures protected from external water loss and infiltration can dry out. This problem is particularly

relevant for concretes with water-cement ratios of 0,4 and below (The Powers Model (1948); Mills, R.H. (1966) Factors Influencing Cessation of Hydration in Water Cured Cement Pastes; Bob Cather (1994) Magazine of Concrete Research; Meeks and Carino (1999), Curing of High-Performance Concrete: Report of the State-of-the-art) and is the cause of subsequent low long-term strength gains.

Self-drying in the surface layer can be eliminated by watering, but it should be taken into account that at low water-cement ratios the flowability of the mixture is so low that external water cannot penetrate into the interior of the concrete (Bob Cather (1994) Magazine of Concrete Research; Meeks and Carino (1999), Curing of High-Performance Concrete: Report of the State-of-the-art), in addition, the surface dries out additionally during self-drying due to internal migration. Therefore, the external surface of concretes with low water-cement ratios can dry out quickly, which further emphasizes the need for watering the external surface of the concrete (Pierre-Claude Aïtcin (1999), High-Performance Concrete). This also confirms that surface properties such as wear resistance and corrosion resistance can be significantly improved during wet hardening of low water-cement ratio concretes, while volumetric properties, including compressive strength, may not be sensitive to surface moisture conditions.

The research also identified possible concrete maintenance periods in Yerevan during the year, based on data from the last 10 years (2015-2024) provided by the RA "Hydrometeorology and Monitoring Center" SNCO.

Table 4 shows the monthly maximum and average air temperatures by the years.

As can be seen from the data, according to average temperatures, watering is necessary for about 4 months, but taking into account the maximum temperatures in May, June, and October, the necessary watering period can be set at 5 months, from May to October.

It is noteworthy that the analyses of both the maximum and average air temperature dynamics for the hottest months of the year (Fig. 6-9) indicate that no obvious global warming trend is observed in the Republic of Armenia. The boundary indicators (2015, 2024) have mainly decreased to 2 degrees or have not changed.

Table 4

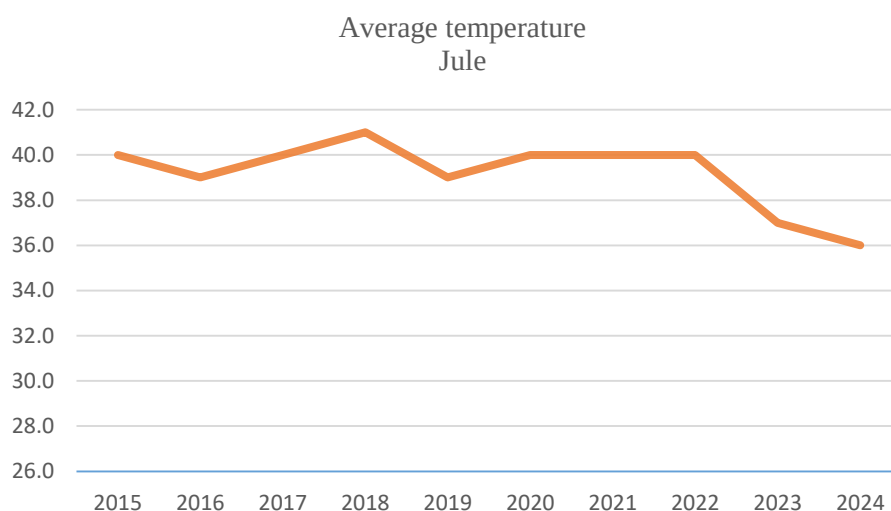
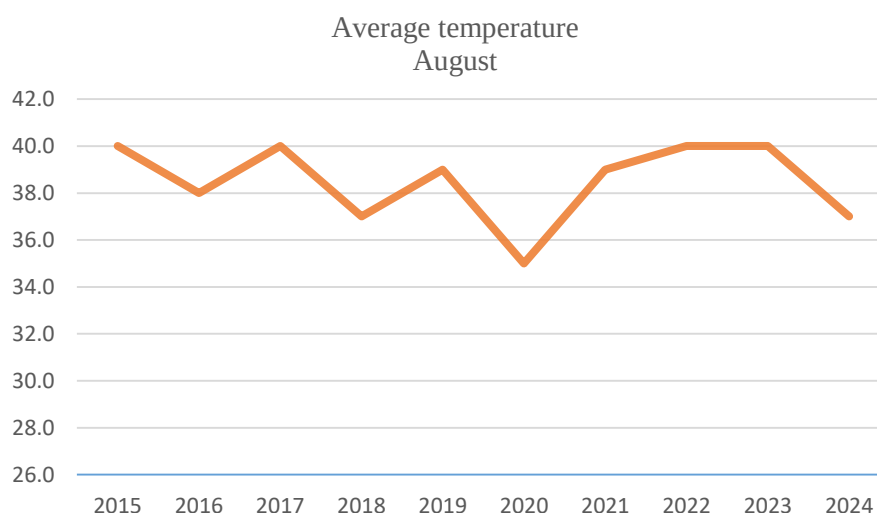
Monthly maximum and average air temperatures by the years

Months	1	2	3	4	5	6	7	8	9	10	11	12
Maximum air temperature (°C)												
2015	12,1	13,7	17,4	26,9	30,2	38,0	40,0	40,0	35,0	28,0	16,0	8,0
2016	10,0	18,0	19,0	28,0	29,0	36,0	39,0	38,0	33,0	30,0	18,0	10,0
2017	-1,0	4,0	19,0	26,0	30,0	39,0	40,0	40,0	38,0	25,0	18,0	13,0
2018	11,0	15,0	25,0	26,0	29,0	38,0	41,0	37,0	35,0	30,0	19,0	12,0
2019	11,0	12,0	16,0	22,0	32,0	37,0	39,0	39,0	31,0	29,0	18,0	12,0
2020	11,0	14,0	20,0	24,0	32,0	35,0	40,0	35,0	36,0	27,0	25,0	9,0
2021	10,0	16,0	18,0	27,0	35,0	40,0	40,0	39,0	37,0	26,0	22,0	15,0
2022	7,0	15,0	19,0	28,0	31,0	35,0	40,0	40,0	39,0	32,0	19,0	11,0
2023	10,0	15,0	23,0	24,0	29,0	34,0	37,0	40,0	37,0	25,0	22,0	13,0
2024	12,0	14,0	20,0	30,0	29,0	36,0	36,0	37,0	35,0	28,0	17,0	11,0

Table 4

Monthly maximum and average air temperatures by the years (Continuation)

Average air temperature (°C)												
2015	0,4	3,7	6,7	11,6	16,8	23,9	27,1	26,4	23,4	13,9	6,3	-1,1
2016	-2,2	3,2	7,3	13,0	16,8	21,1	24,5	27,0	19,5	12,4	3,9	-4,4
2017	-9,5	-6,9	5,7	11,9	17,2	22,8	27,1	27,9	24,2	12,7	7,1	2,1
2018	2,0	5,4	10,4	12,9	17,5	22,5	28,5	25,3	22,6	15,4	7,1	3,3
2019	0,3	2,2	5,1	10,5	18,4	24,6	26,1	26,3	19,5	16,4	5,3	3,2
2020	-0,9	0,6	9,5	9,9	17,4	23,0	25,8	23,3	23,1	15,6	7,1	0,8
2021	-4,1	3,5	5,2	15,6	19,7	25,8	26,3	26,9	21,4	12,6	7,3	1,0
2022	-2,2	3,0	3,4	14,3	15,6	23,6	26,4	27,6	23,0	15,5	8,5	2,4
2023	-0,8	0,3	10,8	12,7	17,1	22,4	25,3	27,6	21,4	14,9	10,2	4,2
2024	1,6	3,9	7,0	16,5	15,8	23,7	25,2	26,2	21,0	13,0	6,8	1,6

**Fig. 6. Maximum air temperature indicators for Jule 2015-2024****Fig. 7. Maximum air temperature indicators for August 2015-2024**

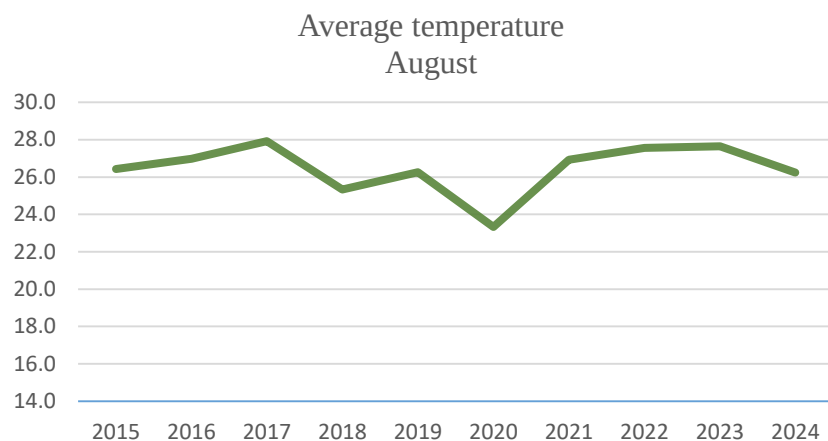


Fig. 8. Average air temperature indicators in July 2015-2024

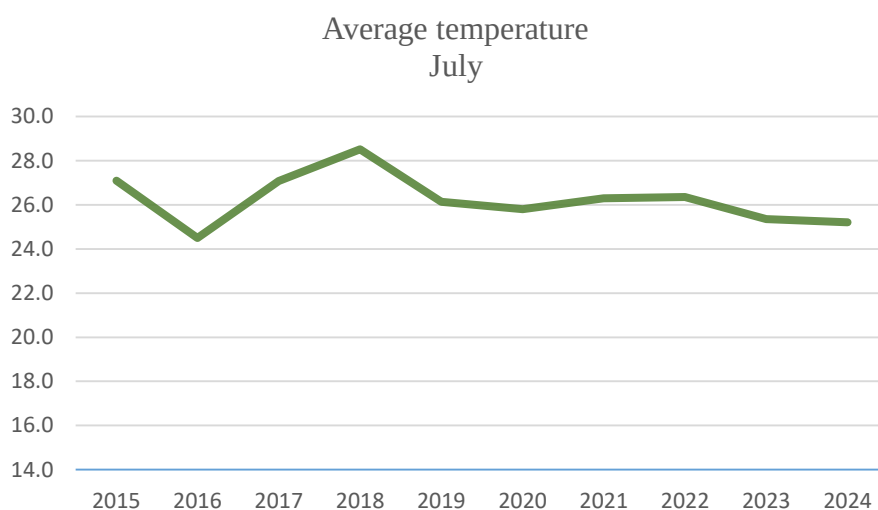


Fig. 9. Average air temperature indicators in August 2015-2024

Analysis of winter climate conditions indicates that no global changes are observed compared to 2015. Concrete maintenance during the winter months is necessary for 6 months: from January to April, November and December.

Conclusion

Concrete curing measures aimed at controlling temperature and humidity ensure that sufficient water is available for concrete to achieve its desired properties in winter and dry and hot conditions.

Taking into account the trend of automation in construction and the results of testing concrete samples prepared with a low water-cement ratio and high-strength cements it is recommended to use the intensive precipitation method for moistening reinforced concrete floor slabs and the shower irrigation method for moistening strip foundations, which provide higher than designed strength indicators at 14 and 28 days of concrete at relatively low water consumption. The intensive precipitation method also contributes to reducing dust on the construction site and creating relatively comfortable

working conditions for workers, as watering is carried out frequently and provides even, long-term hydration.

International organizations' air pollution surveys conducted in Yerevan confirm its high level, especially in the city center. We believe that the spread use of intensive precipitation concrete curing methods, in addition to solving the technical issue, will also contribute to the partial solution of current ecological problems.

Concretes with a low water-cement ratio also achieve higher than designed compressive strength under non-wetting conditions, but may self-dry and exhibit lower wear resistance, corrosion resistance, and high water permeability. The study of the influence of concrete curing on these properties is the subject of further research.

The concrete curing schedules suggested for the conditions studied will be useful to contractors, but the best source of information on the influence of the environment on the achievement of concrete properties is experience, studies of the relationship between certain weather conditions and the achievement of other concrete compositions or design properties, which will allow contractors to be prepared for changing conditions and to organize effective curing.

Studies of meteorological data over the last ten years indicate that no significant changes in average and extreme air temperatures are observed in the Republic of Armenia; the period of dry and hot conditions for concrete maintenance is about 5 months, and half a year for snowy conditions.

References

- [1] **С.М. Анпилов**, Технология возведения зданий и сооружений из монолитного железобетона [Technology of Constructing Buildings and Structures from Monolithic Reinforced], Издательство Ассоциации строительных вузов, Москва, 2010, с.4.
- [2] **M. Shetty**, Concrete Technology. Theory and Practice. S. Chand and Company Limited (ISO 9001 Certified Company), Ram Nagar, New Delhi – 110 055, pp. 270-279.
- [3] **Г.К. Соколов**, Технология строительного производства [Building Production Technology], Akademia, Москва, 2008, 527 с.
- [4] **Ю.М. Баженов**, Технология бетона [Technology of Concrete], Высшая школа, Москва, 1987, 415р..
- [5] **С.А. Любишина**, Технологические процессы в строительстве: учебно-методическое пособие [Technological Processes in Construction], ФГБОУ ВО «КГТУ», Калининград, 2023, 74 с.
- [6] **SP 435.1325800.2018**, Monolithic constructions of concrete and reinforced concrete. Rules of production and acceptance of work.
- [7] **S. Kosmatka, M. Willson**, Design and Control of Concrete Mixtures, The guide to applications, methods, and materials, Fifteenth Edition, Portland Cement Association, Engineering bulletin 001, Washington DC, pp. 166-172.
- [8] **A.M. Neville**, Properties of Concrete, Fifth Edition, Pearson Education Limited, Edinburgh, 2011, pp. 75, 287-301.
- [9] **S. Mindess, J.F. Young, D. Darwin**, Concrete (Second Edition). Upper Saddle River, NJ, 2003, pp. 4-172.
- [10] **ACI 308R-01**, Guide to Curing Concrete, Reported by ACI Committee 308, Farmington, Michigan, USA, 2008, p. 4.
- [11] **ACI 308R-16**, Guide to Curing Concrete, Reported by ACI Committee 308, Farmington, Michigan, USA, 2016, p. 4-19.

**ԲԵՏՈՆԻ ԽՆԱՄՔԻ ԱՐԴՅՈՒՆԱՎԵՏ ԵՂԱՆԱԿՆԵՐԻ ԸՆՏՐՈՒԹՅՈՒՆ ԵՎ ԴՐԱՆՑ
ԲԱՐԵԼԱՎՄԱՆ ԱՌԱՋԱՐԿՈՒԹՅՈՒՆՆԵՐ**

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Բետոնի պնդացման գործընթացի և երկաթբետոնե կառուցվածքների որակի բարելավումը կարևոր նշանակություն ունի նախագծային ֆիզիկամեխանիկական հատկությունների ապահովման գործում: Բետոնի խնամքի միջոցառումները, որոնք ուղղված են ջերմաստիճանի և խոնավության վերահսկմանը, ապահովում են ջրի բավարար քանակ բետոնի անհրաժեշտ հատկությունների ձեռքբերման համար: Ներկայացված են Հայաստանի Հանրապետության կլիմայական պայմաններում բետոնի պնդացման՝ գործող եղանակների առավելություններն ու թերությունները: Վիճակագրական վերլուծությունների և գիտական փորձարկումների հիման վրա առաջարկվել են բետոնի պնդացման արդյունավետ սխեմաներ, տեխնոլոգիական գործընթացի ժամանակացույցեր և ավտոմատացման տեխնիկական միջոցներ:

***Բանալի բառեր.** բետոն, պնդացում, ջրում, արդյունավետություն, փորձարկումներ, վերլուծություն*

**ВЫБОР ЭФФЕКТИВНЫХ МЕТОДОВ УХОДА ЗА БЕТОНОМ И ПРЕДЛОЖЕНИЯ
ПО ИХ УЛУЧШЕНИЮ**

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Совершенствование процессов выдерживания бетона и ухода за железобетонными конструкциями имеет важное значение для обеспечения их физико-механических свойств, предусмотренных проектом. уществ и недостатки существующих методов выдерживания бетона в климатических условиях Республики Армения. На основе статистического анализа и научных экспериментов предложены эффективные схемы выдерживания бетона, графики технологического процесса и технические средства автоматизации.

***Ключевые слова:** бетон, твердение, полив, эффективность, эксперименты, анализ*

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