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The Technology of Production of Precast Concrete by using Solar Energy in Kazakhstan

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Abstract: Solar energy is a-virtually unlimited source whose power on the Earth's surface is estimated at 20 kWh. This is >100 times higher than the predicted values of electric power required for the planet as a whole at the level of 2000; use of this huge energy source is not associated with any environmental pollution. Today, in the face of increasing limitations onnot-reproducible energy resources, complexity appreciation of their production attaches great importance to the use of solar energy. Precast concrete industry is a major consumer of thermal energy and the most energy-intensive technological conversion which consumes >70% of energy, heat treatment products. Among the conditions used in the dry hot climate the heat treatment method of the concrete, the most rational method is solar thermal processing which in recent years has been developed and put into production as an-effective method of heat treatment of concrete products using solar energy in open workshops and polygons as solar thermal processing them using translucent insulating coatings including helio-forma with heat storage elements-helio warming using special film-forming compositions. With the advent of combined methods, solar thermal processing is possible year-round use of solar energy for thermal processing of concrete and reinforced concrete. Methods of heat treatment with the use of solar energy are developed in the factories of precast concrete which until recently was used only steam heating. The variety of ways solar thermal processing provides optimal and economical choice for heating this type of design with minimal costs. Solar technology in concrete production increases energy efficiency during acceleration of concrete hardening including due to the manifestation of the internal power exo-therm cement and soft modes of heating and cooling products contribute to obtaining high-quality finished products. Thus, our studies have shown that the use of solar energy is a promising method of heat treatment of concrete in a dry hot climate the possibility of which has not yet been exhausted. Today, broad investigations which would develop methods solar thermal processing develop new and facilitate their implementation in production. The technology of production of precast concrete by using Solar energy in Kazakhstan.

INTRODUCTION

The precast concrete industry is a major consumer of thermal energy and the most energy-intensive technological conversion which consumes >70% of energy and heat treatment products. Among the conditions used in the dry hot climate the heat treatment method of the concrete, the most rational methods are solar thermal processing. In recent years, have been developed and put into production are effective methods of heat treatment of concrete products using solar energy in open workshops and polygons as solar thermal processing them using translucent insulating coatings, including helio-forma with heat storage elements; helio warming using special film-forming compositions. With the advent of combined methods solar thermal processing possible year-round use of solar energy for thermal processing of concrete and reinforced concrete[1].

Methods of heat treatment with the use of solar energy begins to develop in the factories of precast concrete which until recently was used only steam heating. The variety of ways solar thermal processing provides optimal and economical choice for heating this type of design with minimal costs. Solar technology in concrete production increases energy efficiency during acceleration of concrete hardening, including due to the manifestation of the internal power exo-therm cement and soft modes of heating and cooling products contribute to obtaining high-quality finished products. Despite this, the possibility of the heat treatment of the concrete methods using solar energy is not disclosed and they have not taken place due to the industry. This is due to the relative youth of most methods, insufficient knowledge of the art production workers solar thermal processing due to lack of information. Thus, our studies have shown that the use of solar energy is a promising method of heat treatment of concrete in a dry hot climate the possibility of which has not yet been exhausted. Today, broad investigations into methods of solar thermal processing develop new and facilitate their implementation in production.

In this paper, the author attempts to analyze and synthesize scientific advances on the issue of the use of solar energy for thermal treatment of reinforced concrete, consider the issues of their manufacturing as well as to summarize the results of research conducted by the authors in recent years in the laboratory building materials Kyzylorda State University named Korkyt Ata[2].

Content: The use of renewable energy and converting them in the most suitable form, electricity and heat, costs today is extremely expensive. Today we need to raise funds and develop research aimed at improving the efficiency of clean energy, especially solar. The authors developed effective methods combining solar thermal processing a translucent film-forming composition of the cells under hot dry conditions of Kazakhstan. Theoretical and experimental studies on the effects of dry hot weather on concrete until they reach a critical strength; relative moisture loss showed that there are structural changes that occur due to evaporation of moisture and mass transfer phenomena which could affect the physical and mechanical properties of the material. It is proved that when the value of moisture loss solar thermal processing and combined solar thermal processing that does not adversely affect the properties of concrete at day old in a dry hot climate should not exceed 10%. The relationship between the heat treatment time in the concrete products and the increase of strength of concrete depends on the time of incoming solar radiation. The relationship between the incoming solar energy and the uniformity of the formation of the temperature field in concrete depends on the area of the heated surface and the thickness of the products. It has been established that all concretes subjected solar thermal processing, compression strength and tensile strength in bending higher steamed concrete. A general tendency is to increase the elastic modulus of concrete, solar thermal processing in dry hot climates compared to concretes subjected to steaming at 10-15%. Frost resistance of concrete, solar thermal processing in dry hot climates high coefficient of frost resistance of concrete is in the range 1.05-1.2. Results of the study confirmed in a production environment of *in vitro* experiments have shown high efficiency and ways solar thermal processing the warmer periods of the year as well as high efficiency combined solar thermal processing products during the winter seasons with the simultaneous use of solar energy and additional redundant power sources[3-5].

MATERIALS AND METHODS

Description and research results: Materials for concrete subjected to solar thermal processing. In the manufacture of concrete products using solar thermal processing using film-forming compositions, different kinds of various types of light transparent helio cameras as binders may be used Portland cement 400 or more that meet the all-Union

Table 1: Main characteristics of Portland cement according to GOST 310.1-76-GOST 310.3-76, GOST 310.4-81

		Terms setting (min)		Strength 28 days of age (MPa)	
Type of cement	Normal density test	Beginning	End	Compression	Bending
Portland cement of Voskresensk city factory	26.5	139	214	6.8	42.0
Portland cement of Shymkent city factory	26.4	195	275	6.7	32.7
Portland cement of Karaganda city factory	26.00	300	460	6.3	44.0

Table 2: The chemical composition of cements

Title cement	Cao	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	П.П.П
Portland cement of Shymkent city factory	66.53	22.46	5.06	4.96	-	-	4.52
Portland cement of Voskresensk city factory	54.57	23.72	4.56	4.50	4.07	4.03	2.85
Portland cement of Karaganda city factory	66.4	22.3	5.7	4.7	1.9	0.39	-

Table 3: The mineralogical composition of cement

Title cement	C_3S	C_2S	C_3A	C4AF
Portland cement of Shymkent city factory	61.8	21.1	5.0 15.1	
Portland cement of Voskresensk city factory	60.0	14.0	8.0 13.0	
Portland cement of Karaganda city factory	62.0	14.0	7.5 15.0	

Table 4: Grain structure and size of the module in accordance with State Standard (SS) 8735-77 sands

	Full sieve residue,% when its size (mm)						Passed through a sieve	
Batch No. of sand	5	2.5	1.25	0.63	0.315	0.14	0.14 MM (%)	Gradation factors
1	-	1.4	4.0	15.9	49.5	93.1	6.9	1.64
2	-	2.2	6.3	19.7	65.4	94.3	5.7	1.88
3	-	21.8	28.6	55.5	92.0	99.0	1.0	2.74

State Standard (GOST) 10178-85 and GOST 22266-78, except pozzolanic as well as other kinds of binders that meet specific standards and specifications and obtain the desired properties of concrete at the required timing solar thermal processing.

Studies have shown that when rapid hardening of concrete through the use of solar energy are the most effective quick-hardening Portland cement and slag cement as well as cements whose activity is by steaming GOST 310.4-81 in accordance with sanitary norms and rules 5.01.23-83 not less than the following values, MPa With the brand of cement 400-24; the same 500-28; Same 550 33-600.

Under natural conditions, hot climate sulphate used Portland cement with mineral additives Shymkent factory mark M400. Under laboratory conditions used Portland cement plant Resurrection brand M400. The main characteristics of the use of cement are given in Table 1 and the chemical and mineralogical composition (Table 2 and 3).

Applied Portland cements meets the requirements of State Standard (SS) 10178-85. Aggregates (crushed stone from natural stone, gravel, crushed gravel, sand) satisfy the requirements of GOST 10268-80 and GOST 26633-85.As fine aggregate used quartz sand three parties. The bulk density of the sand of these parties was in 1550, 1526 and 1448 kg m^{-3}; content of clay, dust and silt particles, determined by elutriation was no more than 2.3, respectively; 1.8; 0.5%. Grain composition and grain size module used sands are shown in Table 4. Applied sands meet the requirements of GOST 8736-77. Table 4 Grain structure and size of the module in accordance with GOST 8735-77 sands[6-9].

As a coarse aggregate used limestone rubble fraction 5-20 mm; granite rubble fraction 5-20 mm. The bulk density of limestone rubble was 1290 kg m^{-3} and the density of granite rubble 1392 kg m^{-3} of coarse aggregate grain structure is shown in Table 5. Grain composition of coarse aggregate, determined in accordance with GOST 8269-82. The content of clay, dust and silt particles, determined by elutriation, in all cases did not exceed 0.3-0.6% aggregates satisfy the requirements of GOST 8267-82.

For the mixing of concrete and concrete using watering drinking water. By additives for concrete include organic and inorganic substances or mixtures thereof (complexes) in which the introduction of the concrete composition in controlled amounts directionally adjust the

Table 5: Grain composition of coarse aggregate determined State Standard (SS)8269-76

Type of aggregate	Private residue sieve,% when the amount of 20	5 mm,%	5	The amount of filler, passed through a sieve size 5 MM, %
Limestone rubble Shetpinsk quarry	15	80,5	3,5	1,0
granite rubble of Pikerant quarry	0	55,5	40,7	3,8
granite rubble of Tastak quarry	5,87	60,0	23,22	10,91

Table 6: Parameters of film-forming compositions

Film-forming compositions	Concentration,%	Consumption of at 1 m^2 surface of fresh concrete (g)
Aqueous dispersions products dewaxing oils and oil distillates	20	400
	30	300
	40	200
Water soluble resins and compositions based on them	40-70	300-400
Aqueous dispersions of the individual rubbers (latex) and their blend compositions	38-65	150-300
Resin solutions petrolatum rubbers, etc. Organic compounds	30	150-600
Blend compositions based on aqueous dispersions of rubber (latex) and the products of dewaxing oils and oil distillates	25-50	200-350

properties of concrete mixtures and/or concretes, concretes or impart special properties. As chemical additives can be applied hardening accelerators according to GOST 24211-80, the effect of which is effective at a temperature of isothermal heating concrete 30-70°C. To reduce the water-cement ratio used plasticizers and super-plasticizers/C-3, soap-stock/providing intensification of initial hardening of concrete, in accordance with the manual on the use of chemical additives in the manufacture of precast concrete products and structures (SNIP 3.09.01-85 to)[10-13].

Concrete mix design was carried out by standard methods that achieve (at a minimum flow of cement) required holiday and design strength of concrete. The mobility of the concrete mix shall meet the minimum allowable under seal adopted mode. Film-forming compositions and their use in producing concrete using solar thermal processing.

To protect the concrete from hardening and intensive dewatering simultaneously to provide at its maximum helio-heating solar thermal processing concrete products depending on the production conditions used the following film-forming compositions (Table 6):

- Aqueous dispersions products dewaxing oils and oil distillates based on soft paraffin, petrolatum and ceresin
- A water-soluble resin and compositions thereof
- The individual aqueous dispersions of rubber (latex) and their blend compositions
- Blend compositions based on aqueous dispersions of rubber (latex) and the products of dewaxing oils and oil distillates
- Resin solutions petrolatum rubbers, etc., in organic solvents

Selection of the film-forming compositions and their consumption is performed depending on the moisture barrier abilities products hardening conditions imposed requirements non covered surface of articles, cost and safety of scarcity but also the method of application to the surface of products. Applied compositions have a limited time to form on the surface of fresh concrete continuous moisture barrier, characterized by a protective factor (Ks) is determined at day old in accordance with the recommendations and is at least 70% or Efficiency ratio Curing (EFC), defined by the age of 5-6 h in accordance with and shall not be >0.75[14-18].

Film-forming compositions after applying them to the surface of fresh concrete in hot dry weather no later than 1-1,5 ch constitute a moisture proof film helps to maximize helio-heating concrete products. Film-forming compositions should have a neutral or alkaline reaction and does not cause corrosion of concrete and reinforcement.

Film-forming compositions arenot desirable to apply. On the surface of the concrete which then will be in contact with the monolithic concrete or mortar; on the elements of the joints, unless it is proved that the formed film can be completely removed before the subsequent concrete or mortar works. Film forming compositions should have a consistency enabling them to be applied onto the concrete surface pneumatically or in an airless spray curtain to obtain a uniform coating. The relative viscosity of the film-forming compositions at 200C by viscometer VZ-1 must be no >8 and VZ-4, no >35 sec. The warranty period of storage of film-forming compositions for at least 6 months. Quality film-forming compositions do not give a precipitate does not freeze in containers and should be capable of mixing until smooth using moderate mechanical vibration excitation or compressed air[19, 20].

For applying a coating composition should have only the film-forming composition and the equipment for its application. For fast and efficient application of

Table 7: Technical characteristics of the devices for temperature control

	Characteristic				
Device types	Dimensions	Constructive design	Accuracy class	Temperature measurement range (°C)	No. of contained points
Compensator Recording Potentiometer (CRP) 1	Compact	Showing and recording-conductive	1	0-200	1
Compensator Recording Potentiometer (CRP) 3	Same	Same	0,5	0-100	1
Compensator Recording Potentiometer (CRP) 4	Normally marker	Same	0,25;0,5	0-100 0-200	1; 3; 6; 12
EPP	Same	Same	0,5	0-100 0-200	12; 24
EPS	Same	Same	0,5	0-100	1
Thermohydrometer	Compact	Same	-	0-60	1

film-forming composition to the surface of fresh molded articles products on helio-polygon, apply the following spray equipment:

When small amounts of concrete work, as well as in the manufacture of long structures (trusses, beams, columns), use hand-held sprayers or hand-held spray guns with a hydrodynamic film-forming composition through the spray rod. When large volumes of concrete work, use electrical spray guns or high pressure airless spray with a hydrodynamic film-forming composition, as well as pneumatic Guns from filling with circles or bundled with paint Discharge tanks.

Water-dispersible and water-soluble film-forming compositions in the temperature range of 20-60°C, in which they are applied, do not emit harmful vapors and gases and so when working with them does not require any special precautions. Toxicity formulations are low-hazard chemicals (Class 4 according to GOST 12.1.007-76), inhalation hazard is not due to the low volatility of the product[21].

Temperature control during solidification of the concrete samples was performed using a thermocouple installed in the concrete products. Subsequently, the temperature control is carried out on the surface of articles with electronic thermometers.

Control stripping strength of concrete is carried out as “complex methods of scientific Science Research Institute of building construction (SRIBC)-Scientific Research Institute of Structural Concrete (SRISC)”, in which both used the test results of samples and control modes of concrete hardening and product samples. Control modes of hardening concrete product samples are collected in terms of maturity. An indicator of maturity of concrete is determined by the temperature of the concrete during curing. Apparatus and method for measuring the temperature in the hardening of concrete are shown in Table 7. Control selling concrete strength and durability in the project age is in accordance with GOST 18105-86 for the parties[22-24].

Nondestructive testing of concrete in the manufacture of products is carried out using a sclerometer. The same method was tested before the test on the press and control samples. The sclerometric method validates the strength of concrete in each product not only immediately after the heat treatment but after standing in piles in the summer before sending the finished product to the construction sites.

The results of all types of control are fixed in special journals laboratories. It should be emphasized that the defective product due to heat treatment is practically absent. The observed defects were mainly due to technological disturbances (concrete compacted enough, demixing by poor mixing, etc.). The developed system of quality control of concrete completely justified.

Physical and technical characteristics of concrete-subjected solar thermal processing. The quality of concrete and its work in the design and construction are determined by its properties. The most important of material properties is strength. Growth kinetics of strength and final strength of the concrete will depend on many factors. The main ones are the activity of cement and water-cement ratio. Ceteris paribus growth kinetics strength of cement and concrete largely depends on temperature and humidity conditions[25].

Were investigated concrete on raw materials: granite rubble of Tastak career fraction of 5-20 mm, quartz sand with Mach = 2.3 and Portland cement grade 400 Karaganda plant. For the manufacture of concrete samples was taken of 1: 1.62: 4.04 when the water-cement ratio (W/C)/C = 0.45 slump (OK) DC = 1-3 cm at an ambient temperature τ = 14°C. Experiments were carried out simultaneously on two batches of cubes; the first batch of samples was coated with CHD and placed under the light of the clear coat. In the second, the samples did not cover the UPU and laid under the light of the clear coat. In addition, both parties were subjected to three different methods of combined solar thermal processing. Under the first method involves the following: flat heaters in the form of heat and electric heaters (TEN) are set in the pan helio-camera under the form of articles is solar thermal processing using solar energy and electric heating. In the second heating method, the heating element is mounted directly to the form with concrete, through which additional heat is supplied and simultaneously uses solar

Table 8: Strength of concrete at various ways of combination helio heat treatment

	Combined method of helio heat treatment		
Coating types	Unilateral geliotermoobrabotka method I 22h. MPa/% R28n.t 28sut MPa/%R28n	One-way helio heat treatment II method 22ч.МПа/% $R_{28}^{Н.Т}$ 28сут МПа/% $R_{28}^{Н}$	Two-way helio heat treatment II method II method 22ч.МПа/% $R_{28}^{Н.Т}$ 28сут МПа/% $R_{28}^{Н}$
Water-Dispersed Film-Forming	18,5/53,3	24,7/71,2	29,4/84,8
Composition (WDFFC)	25,8/74,4	37,5/108,1	39,5/113,9
Without Water-Dispersed	7,3/21,0	22,8/65,7	25,9/74,7
Film-Forming Composition (WDFFC)	18,5/53,3	30,4/87,7	34,4/99,2

energy. A third method is also simple to implement. Fresh concrete, covered with a film-forming composition (UPU) is placed in helio-camera equipped with a thermo-electric heaters located in the bottom of the camera the heating elements on top the heating elements. In these methods, the product heated in a complex, due to the absorption of solar radiation and additionally duplicate sources of energy and with a significant participation of exo-thermo cement during daylight hours.

After the 1-, 3-, 7- and 28-day curing methods described by the combined solar thermal processing cubes were tested for compressive strength. The results showed that the strength of concrete manufactured by the second method, when heat is applied on top of the product exceeds 20% as compared with the strength of the first concrete the solid in the first method using heaters in the bottom of the chamber under the form of products. The strength of the concrete produced by the third method, where the additional heat is supplied from above and from below up to 20-30% compared to the strength of concrete-sided solar thermal processing in Table 8.

If we consider the strength of the concrete from the viewpoint of film-forming coating composition, it can be concluded that by using the Water-dispersed film-forming COMPOUNDS (WDFFC), concrete strength increases by an average of 10-30% at all three described methods combination solar thermal processing concrete. With regard to energy consumption in the first method, it amounted to 7.6 kWh m^{-3} while the second method, 8.6 kWh m^{-3} and the third method, 10.7 kWh m^{-3}.

Studies conducted in the same natural hot climates (Aktau). On samples of dimensions 10×10×10 cm and see 10×10 h×40 controlled compressive strength and tensile strength in bending. The studies used a heavy concrete class V22,5 of 1: 1.6 : 2.68 with W/C = 0.55, OK = 5-6 cm, made of sulfate- resisting Portland cement grade 400 Shymkent plant, limestone rubble fraction 5, ..., 20 mm quartz sand with M = 2.74.

Samples were formed not later than 11 am on the same day, at the same temperature and humidity conditions. The maximum ambient temperature during the study was 35°C and a minimum relative humidity of 40%. Immediately after molding the samples were placed in a translucent camera in an open area. Previously, once disappeared from the surface of the samples free water and a water gloss on the surface thereof coated water dispersion film-forming composition. For comparison, samples of which are hardened under normal temperature and humidity conditions. Samples were tested at 1-, 3-, 7-, 28-, 90-day compressive and flexural strength according to standard procedures (GOST 10180-90). The results of these experiments are shown in Table 9.

Studies have shown that the use of transparent light cameras as thermal barrier coatings should lead to significant savings in additional backup power when changing solar radiation during daylight hours and during the year with low positive and negative temperatures. From the experiments it is evident that there is a relationship between the heat treatment time in the concrete product and the concrete strength development versus time solar radiation. The nature of the incoming solar energy varies considerably during daylight hours and as in the autumn and spring and winter compared with summer time in a river. Kazakhstan, the total radiation reaches in summer day 6,8-6,3 kWh m^{-2} and in the autumn and spring seasons is 4-2,2 kWh m^{-2}. There is a relationship between the amount of solar energy and the uniformity of the formation of the temperature field in concrete, depending on the area of the heated surface and the thickness of the products. Character of the formation of the temperature field in the cross section warmed articles to determine additional measures to ensure its uniformity[26-28].

With regard to the duration of the technological cycle aging products in the forms, it is defined by a set time required handling strength concrete is usually 70% or R28n.t stripping strength and it can be depending on the climatic conditions, the type of curing from 2-14 days. In the conditions of a dry hot climate of prime importance characteristics of solar radiation. The duration of aging products is determined by the possibility of acquiring the required concrete strength at the reference parameters of the thermal effects without additional thermal and technological measures to accelerate the hardening of concrete. These temperature conditions are observed during treatment in helio form products of solid section thickness of 100-400 mm when the reference values are in the range: heating rate products 5-7 deg/h, the maximum temperature of 55-70°C warming and cooling of 1.2°C/h and provides for a day old concrete class B15

Table 9: Strength of concrete at helio heat treatment combined method

Condition Hardening	Strength of concrete compressive age day					The tensile strength of the concrete flexural day		
	1	3	7	28	90	7	28	90
1. Normal hardening	-	-	-	31,5 100	-	-	5,3 100	-
2. Helio heat treatment in the light of the transparent chamber with water-dispersed film-forming COMPOUNDS (WDFFC)	15,4/48,94	22,5/79,4	37,0/119,3	37,7/119,6	38,0/120,6	4,6/86,4	5,8/109,4	6,02/113,2

Above the line the strength of concrete in MPa, below the line in% of normal hardening of concrete strength in 28 days of age

-B30 (M200-M400) the relative strength of 45-70% R28 at a total number of degrees, not <1000 h. Generalization of research in this area shows that a large role in heating the concrete at solar thermal processing during the warmer months in the growth of its strength plays thickness and robust articles. Analysis of the temperature curves of various products showed that warming them in helio-form carried out 5-7 h on soft modes with the rise of temperature in the concrete to 65-70°C, the conventional isothermal soaking 5-7 h and slow cooling in the evening and night hours at a rate of 1, 5-2,5°C/h to 35-50°C. However, several products are heated more intensely with reduced thickness and with the highest sun receptive surface. In the non-solar time of day, the thinner the product, the more intense it cools.

Properties of concrete subjected to heat treatment by solar energy on previously developed technologies in compliance with the uniformity of the temperature field and the implementation of measures for prevention of dehydration as proved by many researchers, are not inferior to the properties of parboiled concrete as well as a solid under normal conditions. However, the properties of concrete, combined with bilateral solar thermal processing heating in translucent chamber, with an additional, redundant power of electricity, is little studied and became the subject of special studies. The study of the physical and mechanical properties was carried out on concrete, exposed to a new method of heat treatment, developed by the authors combined with bilateral solar thermal processing heating in translucent chamber, using an additional backup power electricity.

Analysis of the data showed a strength that the strength of concrete manufactured according to the developed method, when additional heat is supplied from above and from below up to 20-30% compared to the strength of concrete solar thermal processing sided.

A study of the effectiveness of the known methods combined solar thermal processing concrete in the absence of solar radiation during the cold period of the year depending on the massiveness of products, said the following. The thinner the product, the greater the amount of energy necessary overdraw to receive at day-old concrete same degree of ripeness.

This explains the large exposed surface (resulting in greater heat losses) at a reduced heat storage capacity (decreasing its thickness) and less heat per unit surface area of cement. Therefore, in order to reduce the amount of extra - redundant power when combined methods helio thermal processing of thin-walled products should strive to create an artificial array. The difference backup energy costs on heating concrete helio-chamber and in open form is 60 kWh m^{-3} for the product thickness of 0.25 m, 110 kVtch m^{-3} product thickness of 0.16 m and <360 kWh m^{-3} product thickness 0.05 m.

Since all of the combined helio heat treatment carried out on the soft mode, the main structural characteristics of concrete subjected to normal hardening and heat treatment combined helio similar. Therefore, testing for frost confirmed these assumptions and all samples survived 300 cycles of freezing and thawing with K = 1.05 - 1.15 range[29, 30].

On the deformation properties of concrete when the load is judged by its modulus of deformation, i.e. with respect to the voltage of the strain caused by his action. The higher the modulus of deformation, the less deformative material. So, we can say with confidence that the elastic modulus of concrete subjected to heat treatment under helio SVITAP, helio heat treatment under the film-forming composition followed by aging, helio heat treatment in a translucent cells in the dry hot climate 10-15% higher than the modulus of elasticity of concrete, subjected to steaming, due to soft modes warm helium at lower temperatures.

The effect of reinforcement products and structures on the properties of concrete at solar thermal processing SVITAP are solar thermal processing under film-forming compounds, followed by aging, solar thermal processing a translucent film-forming composition of the chamber below it can be said that under one of the following methods are no violations of the concrete structure and more it is close to the structure of normal hardening concrete.

When combined methods of solar thermal processing concrete including and especially in winter conditions, steel reinforcement can have a positive effect on the temperature field in the concrete due to the higher thermal conductivity of the metal. Review of the literature showed that the steel reinforcement in the process of warming up the electrode structures can significantly distort the electric field in the concrete and cause significant non-uniformity of the temperature field. Thus, it is necessary to consider when using the combined methods solar thermal processing concrete products and structures and apparently better to use electric heating products heating devices in combination with heating helium. Rational construction of solar technologies in the production of modular and monolithic designs and products.

In modern construction and precast concrete industry, almost all of the methods and combination solar thermal processing concrete are used. In this regard, the right choice of method is important because of its features and capabilities without which it is impossible reducing cost and labor to warm designs. The paper analyzes methods such as solar thermal processing heating of the helium using film-forming compositions, solar thermal processing in a film-forming composition in the light transparent helio cameras combined solar thermal processing a translucent film-forming cells under composition.

Using solar energy to accelerate the hardening of concrete and concrete products manufactured in a landfill, can be arranged in different ways. Not as fast enough to transfer solar technology of existing landfills, working autonomously or in factories. Determining factor of its ease of implementation, the commonly used metal forms as a basis for creating helio-form. Solar thermal processing in translucent cells helio-form with translucent coating or film-forming compositions using maximizes the use of natural solar radiation flux concentration for heating concrete and also contributes to the accumulation of heat products. A helio-form with helio-covers, translucent cameras provide insulation effect hardening of concrete in non-solar time.

Helio camera and helio cap should be set no later than 10 minutes after the completion of its formation, since the initial hardening of unprotected concrete in hot, dry weather is its intense dehydration, leading to the development of large plastic shrinkage in violation of the emerging structure of concrete, reinforced by his main physical and mechanical properties and cause cracking of concrete and earlier, especially concrete products and structures. When helio heat treated products harden within 20-22 h. Preheat concrete in light transparent helio cameras, helio forms with light transparent helio cover film-forming composition is performed on soft modes (rise of temperature to 50-70°C for 5-7 h conditional isothermal holding 5-7 h and slowly cooling the concrete during the night to a temperature of 35-50°C at a rate of 1.5-2.5°C/h depending on the massiveness and the brand of concrete products). It must be borne in mind that while the outer radiation exposure provides a high degree of utilization of the heat of hydration of cement in the most energy intensive stage of the process heating concrete; the helio heat treated products to 50% of the heat that goes to heating the concrete provides internal heat source exo-term cement. When solar thermal processing fails largely prevent the development of physical destructive processes in the fresh concrete, resulting in the structure of its products obtained dense, defect-free and the surface of products without cracks.

During helio heat treatment due to soft modes and at lower temperatures the basic physical and mechanical properties of concrete is slightly higher than that of traditional steamed (in a steam chamber) concrete and are between them and the relevant indicators of normal hardening concrete[31].

With regard to the purpose of the combined modes helio heat treatment products and structures, it is necessary to carry out the acquisition of concrete in the 50-55 day-old and 70% R28. With a combined solar thermal processing of products to purchase in the day old concrete such strength to ensure the least amount of energy and conservation of traditional sources of daily technological cycle of production of articles helio-polygon additional heat to the concrete should be carried out so that the temperature is warming products were approximately the same, in the summer season when the heat treatment product only through the use of solar radiation[32].

Establishing the optimum temperature when combined method keeping concrete products made either in the spring, at the beginning of the period or in autumn, at the end of it. In this case, the optimum mode is due, on the one hand, it is sufficient enthalpy in the concrete in the daily cycle to achieve 50-55% R28 and on the other hand minimal energy consumption (minimum value of the total daily solar radiation for articles of different thicknesses).

To establish the optimum mode using different temperature sensors and recording instruments measure the temperature of the upper and lower surfaces of products (concrete zones spaced approximately 5-10 mm from the top and bottom surfaces of products during heating helio). In this concrete product provided corresponding to the heat content is sufficient to achieve a desired daily age mainly stripping strength at minimal additional cost of conventional energy[33].

When you need to achieve concrete in the daily age of 70% R28 establish the optimal mode of hardening concrete products is advantageously carried out in the hot season. In this pre- nomograms determine the required amount of additional heat that is necessary to bring to this standard size products made from concrete of the brand in a particular climatic region to get at day old 70% R28. Then experimentally selected reference optimum mode and using different temperature sensors and recording instruments that provide for a year to obtain concrete at day-old 70% R28 at minimal cost of conventional energy. To control the flow of electrical energy necessary to use energy meters. The transition to a combined helio heat treatment products require special management systems that allow metered flow of additional energy source, depending on the solar radiation. Control over the combined cycle helio heat treatment should be carried out by continuously measuring the temperature of the concrete in the upper and lower zones of the product. When combined helio heat treatment control concrete strength: stripping, transfer, selling and project age. When using the optional redundant power necessary to conduct continuous monitoring and metering of energy for thermal processing of concrete[34].

Curing should be organized in such a way as to exclude for the required period of time they lost moisture and ensure full hydration and hardening of cement to produce concrete strength is potentially possible.

Determinant in establishing the duration of follow-up care for the concrete is not the time factor and the critical moisture loss relative strength. Thus, it is necessary that concrete follow-up care for already purchased R^{Kp}_{B} strength, eliminating premature loss of water. It is obvious that the greater the W/C ratio, the larger pores and capillaries and requires relatively more tumors to a greater degree to fill them. Therefore, to concretes with higher/C R^{Kp}_{B} should be relatively high.

Combined helio heat treatment can be used in all major technological methods of their production: aggregate-flow, bench and conveyor.

Industrial use of helio technology and its cost-effectiveness: Discussed in the thesis are the aspects of solar energy for heat treatment of precast concrete products and structures in landfills plants indicates a high efficiency of new approaches to the replacement of traditional fuels with renewable energy sources. For we have considered helio technology as being characterized by a very good combination of new technologies with the base. Choice as a core technology of landfill production of concrete and concrete products in metal molds predetermined minimum capital cost and complexity of work with equipment typically form special metal lids, helio cameras with light transparent insulating coatings, the use of different film-forming compositions. This approach allowed the broad and multifaceted approach to the practical work of organizing helio polygons. This may be the timely transfer of the current seasonal ranges on Helio technology does not change the technology of manufacturing products or equipment used, except steaming cameras or thermo-forms that replace Helio forms. At a capital reorganization of production as well as creating new helio polygons questions complete equipment and do not go beyond traditional solutions, for helio precast concrete technology using various methods helio heat treatment does not require the issuance of a special engineering equipment.

Another feature of the Helio technology is saving technologies adopted at the base daily cycle time, thereby providing a predetermined performance line, polygon, plant. This is an extremely important point because as a rule, non-fuel use and switching to natural aging products are associated with prolongation of concrete hardening, lower turnover forms, increasing the complexity of care products and a decrease in output[35].

Finally, application of the technology helio guarantees high quality products and structures as occur in the concrete is not characteristic of other types of heat treatment processes are destructive, physical and mechanical properties of thermally treated concrete helio similar properties of normal concrete curing. As a result, helio-thermal processing of concrete products and structures becomes the most affordable way to accelerate the hardening of concrete in open workshops and polygons Republic of Kazakhstan.

Energy efficiency helio-thermal treatment of precast concrete can and should be implemented outside the period of seasonal operation, primarily helio polygons. To this end, developed multivariate system combined helio heat treatment, providing year-round use of the natural flow of solar radiation through the light transparent coatings of helio cameras andhelio-caps. The deficit is covered by an additional source of heat (steam, electricity, etc.). Energy efficiency year-round helio heat treatment consists of high heat and heat insulating capacity receptive coatings Helio, Helio cameras, as well as strict dosing costs of traditional heat source. As a result, energy savings in the winter months is 15-35% in summer 70-100% and the average annual energy savings are in the range of 50-75% depending on the grade and the thickness of the concrete products[36].

More reliable way helio heat treatment of concrete in the dry hot climate is the combined use of light and clear coating film-forming compositions. This method was developed and implemented by the author on Helio range of concrete products (concrete) (Aktau) Joint Stock Company (JSC) industrial construction management ("USSR") in the Republic of Kazakhstan.

One effective way helio heat treatment is a heat treatment in the light of clear cells with combined use of solar energy and further-redundant power sources located at the bottom and top sides of the product. This technology was developed by Helio authors and successfully implemented in the 2001-2012 year, helio landfill capacity of 5 thousand cubic meters per year Building Materials Plant (BMP) KyzylOrda.

It should be noted that the helio technology has been widely adopted in the CIS countries. Our studies listed under production conditions of heat treatment methods confirmed helio In vitro experiments have shown high efficiency and helio heat treatment methods and combination products helio thermal processing and structures[37].

RESULTS AND DISCUSSION

Basic principles helio heat treatment of concrete. Currently, all types of deposits of organic fuels used in industry as coal, oil, natural gas, etc., not to include true renewable energy. They have a limited supply and the duration of their possible use is uniquely determined by the pace of consumption. Appeal to non-traditional sources, observed around the world, explains how limiting traditional energy sources as well as more critical environmental conditions, caused by the burning of fossil fuels and the emergence of the so-called “greenhouse” effect. The use of renewable energy and converting them in the most suitable form, electricity and heat, is extremely expensive. However, the difficulties that await humanity in the case of increasing or maintaining the rate of growth of the negative impact on the environment as a result of industrial activity and energy production and are forced to seek means to develop research aimed at improving the efficiency and clean energy, especially solar.

On the issue of the use of solar energy for heat treatment of precast concrete in the Commonwealth of Independent States (CIS) and abroad to date conducted a large number of studies, there is also considerable experience in the application of helio heat treatment in the production of products and designs.

One of the main uses of solar energy for thermal processing of concrete products is the use of solar power systems with intermediate heat carrier. As with the use of solar and intermediate coolant most technically developed in relation to the hot water supply of buildings and structures, so the decisions on the use of solar energy for thermal processing of concrete were primarily connected with these systems. The advantages of solar plants with intermediate heat carrier is the ability to provide the preset mode with heat-treated products in closed workshops throughout the year regardless of environmental parameters and the use of natural solar energy flux density in the autumn and spring and even winter. At the same time, depending on the coefficient of heat loss, transmittance of the coating, the receiver absorptivity, the average temperature of the coolant at the inlet and outlet of the manifold coefficient of performance (Coefficient of useful action [CUA]) helio receiver is from 0.5 to 0.6. Along with this, the coolant transport via pipelines, storage in bakah batteries and thermal resistance in the heat exchangers can reduce the utilization of solar energy to 0.25-0.3. In addition, the issuance of special engineering helio equipment and the associated additional costs, prevent widespread adoption of this solar technology.

Another area of solar energy for heat treatment of precast concrete products, as well as to protect them from the harmful effects of the environment in the dry hot climate was the application helio camera different designs. Major decisions in the helio camera are based on experience device greenhouses, with increased ambient temperature in the chamber was provided, mainly due to the greenhouse effect. In general, the use of solar energy for accelerating the hardening of concrete products reduced to helio camera device for a two-step (step for ripening products after their pre- steaming or electro warming) and for the single-stage heat treatment[38].

Helio camera ripening concrete products with a two-stage heat treatment can significantly reduce the cycle steaming, increase the turnover of traditional steaming chamber and forms and hence the output of workshops and polygons. However, with the positions of their energy efficiency discussion since their use most energy stored thermal treatment step heating of the product, forms, fences etc. steaming chambers to which spent between 100 and 200 kg of steam per 1 m of concrete.

The helio camera’s two-stage heat treatment of the concrete has not found practical application. This is explained mainly by their energy efficiency is not, especially for regions with dry, hot climates, additional complexity when exposed to these product (device to multiple cameras, crane operations, etc.).

Helio camera for single-stage heat treatment of precast concrete as opposed to solar with intermediate heat carrier are fairly simple design, it does not require special equipment. The use of solar energy in such helio cameras in the hot season and an additional backup power from traditional sources in the autumn-winter-spring seasons saves a lot of heat.

However, such helio cameras have several disadvantages and they are not only the main drawbacks of traditional repeated steaming chambers are new and unique to them. Firstly, it relates to the creation of the desired humid environment in the chamber. In such helio cameras gauging water rapidly evaporates during heating of hardening of concrete which causes a loss of moisture reaching 30-40% mixing water and lead to serious disruption of the concrete structure, reducing its strength and deterioration of other physical and mechanical properties. Another serious drawback is the inefficiency helio cameras stacking products, when in range of direct and diffuse solar radiation are products located only in the top row of the stack or pack products, all other products are heated due to convective heat exchange with the heat flux of the order of 25-50 W/m at a rate not exceeding 0.5-1 deg. h[39].

At this speed, even heating of the concrete strength in preventing loss of moisture from it cannot achieve the desired values for day and, therefore, needs a two-day production cycle, reducing productivity. Because of the above drawbacks the main chamber helio single step heat treatment of precast concrete products are not currently used. Thus, the analysis of known solutions and experience in the use of solar energy for thermal processing of concrete have shown that even the best of the considered technical solutions cannot be used for large-scale production of precast concrete with a complete rejection of additional sources in the summer. Here we need new approaches to the heat treatment of reinforced concrete, providing high efficiency heat utilization of solar radiation[40].

For intensive hardening of concrete with the use of solar energy by the authors, a method was developed in solar thermal processing precast concrete products in translucent chambers of polymeric materials using film-forming compositions for dry hot climate conditions, namely the Republic of Kazakhstan Aktau. This method of solar thermal processing concrete products in the translucent film-forming composition of the cells under can be used in open workshops in the areas of polygons and the CIS, located south of 500 north latitude. This method provides a high quality concrete with the required stripping or selling strength at significant savings of fuel and energy resources.

Despite the implementation of various measures to increase the seasonal period of operation helio-polygons and expand the range of manufactured products, precast concrete solar thermal processing rest of the season. To ensure year-round use of solar technology is necessary, together with the use of solar energy in addition, redundant sources of thermal energy, i.e., combined solar thermal processing products.

Large effect gives application of the method in combination solar thermal processing translucent cameras using film-forming composition, as well as heating elements to use one type of electric heaters. This method was developed by the authors for the conditions of the Republic of Kazakhstan Aktau. The authors of this work were developed and introduced other varieties of ways solar thermal processing to dry hot conditions of the Republic of Kazakhstan Kyzylorda city. The main difference between them from the existing accommodation is electric heaters in the upper part and the lower part of helio camera. Thermal energy supply is carried out from above, from below and from above simultaneously while using solar energy.

New approaches to technology solar thermal processing concrete in dry hot climate of the Republic of Kazakhstan give savings of 50-100% of traditional fuels by heat treatment of precast concrete; a clean environment, free of smoke emissions boiler; guaranteed high quality products and designs with the diurnal cycle of turnover forms.

Theoretical aspects of the use of solar energy for thermal processing of concrete. Concrete structure is formed by the solidification of the concrete mix. Decisive influence on its formation have hydration of cement, its setting and hardening. The structure of the cement paste from mixing with water is in constant change. These changes are caused by external forces acting under stirring and compacting the concrete mix and internal physical and chemical processes, primarily cement hydration.

To accelerate the hardening of concrete used in different ways: heat steaming, electro thermal, the use of solar energy. As is well known heat accelerates the chemical reaction but the phase composition of the products of the cement hydration hardening at different temperatures, remains substantially the same. Increasing the intensity of Brownian motion with an increase in temperature of the liquid thus increases the kinetic energy of the molecules of the liquid which determines the strength of their interaction with the binder. The pressure increase with increasing temperature is due to the increase of gas velocity of moving molecules. Occurrence of pressure in the concrete depends on the warm-up process is enhanced considerably when the concrete temperature 600°C. Typically, with warming concrete surface and therefore an excessive pressure occurs primarily at its surface. With slow heating the overpressure is very small, since moisture migration from the region of elevated pressure in the cooler parts of the product and may reduce the vapor diffusion overpressure. With a very rapid heating of these factors do not have time to manifest adequately overpressure increases dramatically which in some cases can lead to irreparable defects and marriage. On cooling the concrete internal stresses, since it formed a uniform structure prevents the thermal contraction. This gradually relaxes internal stress but has some effect on its strength characteristics, reducing their number, especially when tested immediately after cooling and they are also the cause. Thus, in all the methods of heat treatment of concrete must be warm and soft as many investigators found the rise in temperature of heating and cooling of the concrete should be slow and not <200°C and the isothermal hold at a temperature not exceeding 800°C.

Hot and dry weather is making serious complications in concrete technology and causes a lot of negative consequences. Therefore, blocking the destructive processes occurring in the flow of plastic shrinkage of concrete, due to intense dehydration in a dry hot weather, achieved effective curing[41].

It is known that the greatest influence on the formation of the concrete structure has a start-up period of hardening, in which intense flow various physico-chemical and physical processes. Main criteria forming the structure of the concrete hardening at elevated temperatures and low relative humidity environment, the researchers adopted the magnitude and character of the physical processes such as thermal expansion of concrete, plastic shrinkage and its value of moisture loss. A special place among the physical processes occurring in the fresh concrete at solar thermal processing takes his dehydration. If you violate technology solar thermal processing or wrong manicured concrete in hot, dry weather during the first day to lose 50-70% of mixing water, with the bulk of it is removed from the concrete in the first 6-7 hours of hardening[42].

Intensive evaporation of moisture from the fresh concrete results in considerable largest plastic shrinkage which is in the hot and dry weather the physical destructive process that violates the emerging structure of concrete, significantly impairs the physical and mechanical properties and one of the reasons for early cracking of hardening concrete.

Concrete Research moisture loss for 6 hours at t = 360°C, f = 23% in hot, dry weather were conducted by the author in dry Kyzylorda Region hot climate region. These studies have shown that when combined solar thermal processing of concrete when concrete is done by heating the joint use of solar and electric energy value moisture loss 6 h after completion of the molding is 4.3 and 7.2% , respectively of the mixing water for latex and latex composition water dispersion composition (WDC1) of (WDC 2). A sample of the solid in the form of open water without the dispersion of film-forming composition WDC lost for 6 hours 36.2% of mixing water. Thus, this study confirmed the efficacy of combined solar thermal processing concrete under film-forming composition because in this method of solar thermal processing moisture loss not exceed 8%.

The problem of the influence of the magnitude moisture loss intensity dehydration, plastic shrinkage on hardening concrete structure in the dry hot climate devoted quite a large number of publications. Experiments conducted by the authors argue that the value of moisture loss at solar thermal processing and combined solar thermal processing that does not adversely affect the properties of concrete at day old, should not exceed 10%. As noted above, favorable humidity conditions of hardening and soft mode heating concrete at solar thermal processing products should have a positive impact on the formation of the structure and physical-mechanical properties of concrete. This is firstly due to the fact that heating solar thermal processing concrete in the first few hours hardening (6h) occurs without the occurrence of significant temperature gradients adjustment section products. In this connection it is of interest to study the characteristics of the structure and the basic properties of concrete subjected to various methods solar thermal processing.

Solar thermal processing in translucent cameras using film-forming composition provides soft modes of hardening concrete which should have a positive impact on the formation of its structure and physico-mechanical properties. As a result of structural studies it can be concluded that the concrete is subjected to electrical heating, solar thermal processing in translucent cameras and film-forming composition under helio warming characterized mainly by a dense structure of the mortar with good grip coarse and fine aggregate with the cement mass. As concrete subjected to the film-forming composition under the electrical heating solar thermal processing and under film-forming composition, characterized by a high content in solution of evenly distributed small pore size and a higher degree of hydration, in contrast to the concrete subjected to electrical heating and under film-forming composition under the film-forming composition helio warming is translucent chamber[43-45].

Solar thermal processing in translucent cells largely prevents intensive dewatering of concrete that does not lead to destructive processes but the effect on the heat balance helio form and requires consideration by the use of one-way flow of solar radiation natural concentration. In addition, as a result of differences in the heat capacity and the absorption capacity of the concrete material appears translucent and the temperature difference between the heated surface of the article and a coating. This leads to the condensation of moisture on the surface of the product facing the translucent material which degrades its optical characteristics. One of the features in the development of mass-transfer processes is that the step of radiation heating evaporation and product moisture condensate formation damped 1-2 h after establishing translucent chambers. Condensate film increases the water absorbing capacity of translucent material and its temperature to values close to the temperature of the surface of articles. Another feature is the resumption condensate formation in the evening, after the termination of the sun. The rate of concrete and water losses from evaporation effect under cooling with 2-2.5 times higher than at heating of the product[46-48].

Thus, intensive mass transfer processes using heat treatment to intensify the hardening of concrete leads to rapid evaporation of moisture from the non-covered surfaces which significantly violates the emerging structure of concrete and impairs its basic physical and mechanical properties, primarily in the surface layers of the heated structure.

The heat treatment should strive to gradients of temperature and humidity were minimal or lower limit, at which the visible structural damage in concrete. The limiting gradients depend on the degree of hardening (maturity) of the concrete structure at the beginning of heating and other factors and may be determined empirically. When tested solar thermal processing they can reach 0,4-1,040°C/cm combined methods solar thermal processing 0.7-1.10°C/cm[49].

Identified patterns of heat and mass transfer in different ways solar thermal processing concrete allow more professional approach to the appointment of its parameters and keeping the molded structures to purchase the required strength. Dehydration process of hardening concrete at an early age is the most characteristic feature of the aging structures and products in a dry hot climate, accompanied by a loss of mobility and complication of laying of concrete mix as well as the deterioration of the structural and mechanical properties of hardened concrete. Maintaining the quality of concrete in the construction of reinforced concrete structures under these conditions is ensured by a series of events that prevent premature dehydration of concrete. These include maintaining and under SVITAP, light transparent helio cameras of polymeric materials under different film-forming compositions for film-forming compositions, followed by holding thermos products and designs[50].

According to many authors, the minimum duration of care should be determined not by the time care and maturity which can be considered an indicator of the relative strength at the time of his termination. Purchase of concrete strength relative to a certain critical moisture loss indicates that his physical structure was formed, the pores and capillaries largely filled tumors that hinder intensive moisture migration.

Also in this concrete mechanically bound moisture is very little evaporation and can no longer be sharply negative effect on the structure of the material.

Analyzing the modes of the most effective types of helio thermal processing of concrete in a dry hot climate can be noted that the main mode selection is an experimental treatment of concrete and concrete products and structures to assess the physical and mechanical properties. The results of investigations of temperature fields hardening samples and real products show that their warm- radiative flux until the concrete at day-old 50-70% R28 on soft modes in which the rate of temperature rise of concrete is 5-70C°/h, the duration of the conventional isothermal holding at maximum temperature of 60-700°C for 5-7 h and cooling to a temperature of 35-500°C occurs at a rate of 1.5-2.50°C/h depending on the massiveness product grade of concrete, the ambient temperature and others. Such regimes create favorable conditions for curing which should have a positive impact on the structure and properties of concrete. The results of studies on the effects of dry hot climate hardening concrete at various ways helio thermal processing provide the necessary data for the construction of modes to warm modular and monolithic structures.

Developed various methods and technologies of production of precast concrete products for different purposes with the intensification of concrete hardening through the use of solar energy; the possibility of complete abandonment of the traditional steam warming products in landfills in hot climates with helio thermal processing[51].

CONCLUSION

In the transparent light camera chambers of polymeric materials using a water dispersion of film-forming composition in combination with the methods of electro thermal processing as redundant power, providing high quality precast concrete with a daily cycle of production, saves a lot of heat and create environmentally clean production including in cloudy and rainy weather. Helio thermal processing of concrete products in the light of clear cells of polymeric materials using a water dispersion of film-forming materials (UPU) introduced on Helio range of reinforced concrete products (Aktau) Joint Stock Company "Industrial Construction Management". Helio thermal processing of concrete structures in combination helio camera using a water dispersion of film-forming materials (WDFFM) is implemented at the complex of building materials (CBM) Kyzylorda city Kazakhstan.

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